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California Solar Initiative Market Transformation Study (Task 2)

Final Report – Appendices

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The California Public Utilities Commission

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Appendix A Evaluation Methodology

This appendix provides details about the approaches, assumptions, and sample sizes that the Navigant Consulting, Inc. (Navigant) team used during each phase of its data collection and analysis efforts. It includes information about each of the following data sources and research phases:

- California Solar Initiative (CSI) PowerClerk database analysis (Section A.1)
- Utility interconnection data analysis (Section A.2)
- Market actor in-depth interviews (IDIs) (Section A.3)
- Host customer surveys (Section A.4)

A.1 Analysis of PowerClerk Database

The Navigant team used the CSI PowerClerk database for a large portion of its market characterization analysis and sample frame development. The team was provided access to the full, non-public version of the raw PowerClerk data so that it could analyze additional aspects of program participation (e.g., market share by different third-party owner [TPO] firms). As a result, much of the Navigant team's analysis will differ from that which appears on the California Solar Statistics (CSS) website (the publicly available CSI data). Some of the reasons for the differences might include the following:

- The Navigant team generally used median cost and capacity numbers in order to minimize the effect of outliers. The CSS data generally reports average numbers.
- Many CSS cost statistics assign individual projects to a date (i.e., quarter or year) based on when the project's incentive reservation was confirmed. The Navigant team's analysis, however, assigned projects based on when they were installed. In general, the incentive reservation date may occur from several days to more than a year before the actual date of installation (particularly for non-residential projects). This may cause individual system size and cost data from the CSS analysis to be counted at an earlier date than in the Navigant team's analysis.

The remainder of this section highlights general assumptions and approaches the team used in its PowerClerk data analysis, which it conducted using both Microsoft Excel and R.[1]

A.1.1 General Assumptions

The data set the Navigant team used for its analysis was extracted from PowerClerk on March 19, 2013; however, the team's analysis considered only systems that had been installed by December 31, 2012. The team assumed a system had successfully been installed if its CSI application status had achieved at least

[1] The R Project for Statistical Computing, http://www.r-project.org.

the "Incentive Claim Request Submitted" stage.[2] As a proxy for the installation date, the Navigant team used the "First Incentive Claim Request Review Date," which is the nearest date to the estimated installation.

Most of the market characterization analysis considered median values for system sizes and costs in order to minimize the effect of any outlier data. The team also omitted any Multifamily Affordable Solar Housing applications from its analysis.

Estimates of the share of the two TPO financing approaches (i.e., leases and power purchase agreements [PPAs]) were based on the answer provided in the "Financing Type" data field. For third-party-owned systems where no financing type was indicated, the team allocated those systems across the two contract types in proportion to their respective market shares in the year in which those "blank" systems were also installed.

A.1.2 Assumptions for Supply-Chain Assessment

One of the key data fields not provided in the CSI Working Data Set is the listed system owner, which CSI omits to protect individuals' personal information. For third-party-owned systems, however, this data provides a useful view of the market share of the photovoltaic (PV) systems financed by various solar PV finance companies. For many TPO systems, the listed "System Owner Firm" is often a special purpose entity (SPE) or limited liability corporation that, at first glance, is not a commonly recognizable player in the solar PV industry. Rather, these entities serve as the conduit for solar PV finance companies to aggregate a portfolio of solar PV projects to which they and their investors can direct their project investment funds. To help elucidate TPO market share for its supply-chain analysis, the Navigant team spent considerable time matching these various SPEs to the solar PV finance companies with which they are associated. The team was able to make connections between the individuals' names, email addresses or phone numbers listed for various entities to group them appropriately.

A.2 Comparative Analysis of Interconnection Data

The Navigant team used each investor-owned utility's (IOU's) interconnection database to assess the degree to which customers were installing solar PV systems without the use of a CSI incentive. Each IOU data set included an "incentive program" or "funding source" data field that enabled a straightforward assessment of the proportion of PV systems interconnected each year that received such an incentive. Notably, IOU evaluation staff suggested that interconnection applications might not have consistently captured that data over time, particularly in the CSI Program's earlier years (2007-2009). The Navigant team therefore excluded the 2007 data from its analysis.

In addition, the Navigant team noted that each IOU has a different way of accounting for incentive program participation on the current versions (as of January 2014) of their Interconnection Application forms. Their respective approaches are summarized as follows:

[2] The seven application statuses that the Navigant team included as Installed were: Incentive Claim Request Review, Suspended – Incentive Claim Request Review, Payment Pending, Performance-Based Incentive (PBI) In-Payment, Completed, Site Transferred, and System Removed.

- The Pacific Gas and Electric Company (PG&E) application has a place near the beginning of the form where applicants can check one of two boxes indicating whether they intend to apply for either a CSI rebate or a New Solar Homes Partnership (NSHP) incentive. There is no box to indicate that no incentive will be received. In its analysis, the Navigant team assumed that those in the PG&E database that left both boxes blank did not participate in CSI.
- The San Diego Gas & Electric Company (SDG&E) application has three choices at the beginning of the form: CSI incentive, NSHP incentive, or "Not Applying for any rebates."
- The SCE application has several choices and asks applicants to "check one." These choices include: CSI-PBI; CSI-Expected Performance-Based Buydown; Self-Generation Incentive Program; California Energy Commission-NSHP; and the Emerging Renewables Program. Notably, "None" is not a choice. This could increase the chance that people incorrectly choose one of the options, even though they are not receiving an incentive.

Regardless of these differences, the Navigant team made a simplifying assumption that one might reasonably expect any inaccuracies in each IOU's interconnection data to occur somewhat consistently over time. It is therefore the trend within each IOU's data over time that provides the best indication of change.

In an effort to further validate its analysis, the Navigant team attempted to conduct a parallel analysis that compared the gross capacity and number of eligible PV systems interconnected annually in each IOU territory (based on the interconnection data) with the number and capacity of systems installed each year based on the CSI PowerClerk data. Data inconsistencies and scope limitations made it infeasible for the Navigant team to match each listed system individually between the two data sets; however, the Navigant team anticipated that a comparison of aggregate numbers might provide a reasonable second estimate of the share of interconnected systems receiving a CSI incentive.

Unfortunately, a lack of comparable system installation dates between the two data sets made even aggregate-level analysis difficult. While the IOU interconnection databases provide the date for interconnection approval, the closest comparable date in the PowerClerk data is the "First Incentive Claim Request Review Date." This PowerClerk date—when the CSI Program Administrator starts reviewing the applicant's request for payment—is the best approximation of when the system was installed (a prerequisite for claiming an incentive). Actual system interconnection, however, may happen well before (or occasionally after) such an incentive claim has been filed. The resulting annual trends from this comparative analysis appeared to generally follow those based solely on the interconnection data; however, in most cases, the resulting estimate of non-incentivized systems varied significantly from that shown in the IOU data (usually much greater).

As a result (and to avoid confusion), the Navigant team did not report the results of this comparative analysis. A better comparison could be undertaken by matching specific customer names or addresses between the two data sets; however, the interconnection data on its own provided a reasonable enough estimate of any trends in the metric over time.

A.3 In-Depth Interviews

IDIs with market actors provide the opportunity to engage in dynamic conversation with organizations and individuals that possess an intimate knowledge of the California solar PV market. By building rapport with each interviewee, the research team was able to probe for details, glean information on sensitive issues, and obtain clarification as needed. The Navigant team completed a total of 63 IDIs across two different points in the research effort. Phase 1 IDIs helped inform the characterization of the California solar market and the team's understanding of key market barriers and the policies that interact to address them. Phase 2 IDIs focused on informing Navigant's assessment of its prioritized market transformation indicators.

A.3.1 Data Collection Approach

The Navigant team conducted telephone interviews with senior-level individuals at organizations in various market actor categories. Respondents were recruited via e-mail and telephone, and the interviews generally lasted between 45 and 60 minutes (Phase 1) and 20 and 30 minutes (Phase 2). The questions were primarily open ended and qualitative in nature, allowing interviewers to ask probing or follow-up questions as needed. Interview staff recorded each interview (with permission) to help ensure the accuracy of responses, with full transcriptions completed for each conversation. However, Navigant also assured anonymity to each respondent (and their organizations) to help encourage open and candid remarks about the market and the CSI Program.

A.3.2 Sample Design Approach

The Navigant team focused its interview sample approach to achieve two main goals: gaining a diversity of perspectives from market actors across the supply chain and including input from those firms that play leading roles in the California market. For solar PV finance companies, installers and manufacturers, this generally meant targeting those firms with the largest shares of installed capacity. Table A-1 shows the final sample disposition for each of the Phase 1 and Phase 2 interviews, including notes on the number of types of organizations targeted in each market actor category.

A.3.3 Addressing Respondent Bias

Potential respondent bias is a common area of concern in many policy and energy program evaluation studies, particularly those that include a substantial qualitative data component. Given the incentive-based nature of the CSI Program, as well as the role of electric rates and regulations (e.g., tiered rates and net energy metering) in the economics of customer-side solar PV, there is a risk that market actors' inherent biases would influence their responses. Further, some market actors may specifically perceive the interview process as an opportunity to influence a study's conclusions, including any resulting recommendations related to policies, regulations or other factors that would work in their firms' favor.

The Navigant team regularly encounters this risk of potential bias in its market assessment and program evaluation research, and uses several industry best practices to mitigate its role in the team's analysis efforts. These include: 1) triangulating interview samples to include market actors that represent different points of view from different points in time; 2) using actual data, when available, to corroborate the responses we receive from market actors; and 3) obtaining responses from several parties within an organization. For this particular evaluation, the team also sought to gather input from a wide range of

individuals and firms both within and across several different categories of actors in the customer-side solar PV market. Where possible, the team compared the responses of individuals in those different market actor categories to identify discrepancies or inconsistencies that could indicate bias at play. For example, the team specifically sought to interview two sets of solar PV contractors – those that primarily work with solar PV finance companies and those that largely function independently – to gain differing perspectives on the role and practices of solar finance company (SFC) firms in the market.

Table A-1. Market Actor Interview Sample Disposition

Market Actor Category	Phase 1 Target	Phase 1 Complete	Phase 2 Target	Phase 2 Complete	Notes
Residential Solar Finance Companies	3	3	5	6	Targeted top 12 firms by 2012 capacity installed. Interviewed firms represented 91% of 2012 CSI market share for residential TPO systems.
Non-Residential Solar Finance Companies	2	2	4	3	Targeted top 7 firms by 2012 capacity installed. Interviewed firms represented 55% of 2012 CSI market share for non-residential TPO systems.
Solar Installers	5	5	7	8	Identified 36 target firms based on 2012 capacity installed. Prioritized those with larger market share or that work with leading SFCs. Interviewed firms represented around 60% of 2012 CSI market share for the installation of TPO systems in both residential and non-residential sectors.
Providers of Capital	5	6	6	6	Identified 31 target firms via industry news coverage. Included venture capital, private equity, investment banks, and investment arms of major corporations.
Solar Equipment Manufacturers	5	5	6	6	Targeted top 10 panel and top 10 inverter manufacturers by 2012 capacity.
Other Market Experts			4	4	Targeted individuals at state and federal agencies and law firms who have historical insights into the California market.
California Government Agencies			6	6	Targeted municipalities in each IOU territory with high levels of installed capacity.
Program Administrators in other States	4	3			Targeted solar PV rebate program administrators in states with same characteristics as California (e.g., high power prices, good solar PV resource).
CSI Program Administrators			3	0	Interviewed staff from each of the three CSI administrators.
TOTAL	**24**	**24**	**41**	**39**	

Source: Navigant team analysis.

A.4 Solar Host Customer Surveys

Surveys with current and potential solar PV host customers were instrumental in determining the market transformation effects of CSI and other market factors, as well as remaining or emerging barriers that may hinder the market's sustainability. The Navigant team's underlying goal for its survey effort was to strike an appropriate balance between the breadth of coverage across various customer segments (i.e., residential and non-residential, participant and non-participant) and the statistical reliability of the data collected for each segment.

A.4.1 Data Collection Approach

The Navigant team employed a professional survey research firm, Ewald and Wasserman (E&W), to conduct telephone surveys with participants and non-participants in both the residential and non-residential market sectors. Participant surveys averaged 17 minutes in length; non-participant surveys averaged 5 minutes. The questions were a mix of open-ended and multiple choice questions; open-ended questions had pre-coded answers. E&W conducts telephone research via a Computer-Assisted Telephone Interview system to ensure proper implementation of skip logics and accurate data collection. Interviewers are trained to strictly adhere to the script, which includes an assurance that responses are confidential and not linked to the individual respondent in any way. E&W sent advance letters to residential and non-residential participants that told them to expect a call from E&W.

A.4.2 Sample Design Approach

The Navigant team conducted surveys across four primary market segments: participants and non-participants in each of the residential and non-residential sectors. The team relied on CSI PowerClerk data to identify solar PV participants and used geographic (residential) and sector identification information (non-residential) to identify potential non-participants. Within each population (participant/non-participant) and sector (non-residential/residential), the team sought to achieve statistically significant results at the ownership subsegment level (i.e., host-owned versus third-party owned). Samples were designed to achieve 90/15 confidence/relative precision criteria at each of the eight subsegment levels and 90/10 confidence/relative precision at the sector level for participants and non-participants. All estimates assumed a two-sided confidence interval and a coefficient of variation of 0.50. Additional details on the sampling strategy implemented for each segment appear below.

Note that while the Navigant team designed its survey sampling approach around specific confidence and relative precision targets, the calculation of the relative precision actually achieved at those confidence levels is frequently an impractical (and sometimes impossible) undertaking. For simplicity, the team's sample design assumes that each survey question will result in a numerical response that falls somewhere among a range of all sample responses to that question. A straightforward calculation of the resulting relative precision relies substantially on the calculated (numerical) variation among these values. In the case of a binomial question (i.e., yes/no answers), these calculations are more complex. For survey questions where responses are grouped or categorized (i.e., multinomials), these calculations are often unsolvable.[3] To improve the usefulness of its analysis and results, the Navigant team combines this

[3] Leslie Kish. 1965. *Survey Sampling*. John Wiley & Sons, Inc. New York.

estimate of the relative precision of its sample strata with a Chi-square approach to ensuring the statistical significance of the results for each question that we ultimately include in our analysis and findings.

A.4.3 Residential Participants

The PowerClerk data allowed the Navigant team to narrowly define the target sample size for its participant surveys based on most recent updated information through the end of calendar year 2012. Again, the team targeted 90/15 relative confidence and precision for customers with installed systems at each of the host-owned and third-party-owned subsegments. TheNavigant team distributed the 32 completions required in each of these subsegments across the three utility territories in proportion to each utility's CSI Program capacity goals. The target of 32 completes in the host-owned sector was exceeded. The sample for third-party-owned systems was divided equally between systems with leases and PPAs. Table A-2 shows the final disposition of this sample, including confidence and precision targets.

Table A-2. Sample Disposition for Residential Participant Phone Surveys

Utility Territory	Population Size	Sample Size	Estimated Relative Precision*	Confidence
Host-Owned	**52,908**	**39**	**13%**	**90%**
PG&E	29,308	17		
SDG&E	8,043	5		
SCE	15,557	17		
Third-Party Owned	**33,940**	**32**	**15%**	**90%**
PG&E	15,971	15		
SDG&E	3,590	5		
SCE	14,379	13		
TOTAL	**86,848**	**72**	**10%**	**90%**

Note: *Assumes a coefficient of variation of 0.50

Source: Navigant team analysis of PowerClerk database extract through December 31, 2012.

The Navigant team pulled a random sample of records within each system ownership and utility sub-segment using a random number generator in Excel. The surveys included screener questions to verify the ownership structure used for each respondent's PV system.

A.4.4 Non-Residential Participants

The team used a similar approach for the non-residential participant sample. Given the relatively smaller number of individual system host customers and the need to share a sample frame with the parallel Third-Party Ownership study, the team did not seek to achieve utility-specific targets within each system ownership segment. Table A-3 shows the final disposition of this sample, including confidence and precision targets.

Table A-3. Sample Disposition for Non-Residential Participant Phone Surveys

Ownership Type	Population Size	Sample Size	Estimated Relative Precision*	Confidence
Host-Owned	3,057	38	14%	90%
Third-Party Owned	1,129	28	16%	90%
TOTAL	4,186	66	10%	90%

Note: *Assumes a coefficient of variation of 0.50

Source: Navigant team analysis of PowerClerk database extract through December 31, 2012.

Again, the Navigant team selected its sample frame for each ownership segment using a random number generator and verified the ownership structure for each host customer system during the survey.

A.4.5 Residential Non-Participants

For the residential non-participant sample, the Navigant team targeted homeowners within each of the three IOU service territories. To help ensure diversity in its sample, Navigant sought to include customers from each of four income level segments in each IOU territory. A target of 90/15 relative confidence and precision sought to enable statistical comparisons across income levels. Table A-4 shows the final disposition of this sample, including confidence and precision targets.

Table A-4. Sample Disposition for Residential Non-Participant Phone Surveys

Household Income Level	Estimated Population of Homeowners[1]	Sample Size	Estimated Relative Precision*	Confidence
First Quintile	500,000	N/A		
Second Quintile	1,220,000	73	10%	
Third Quintile	1,220,000	77	10%	
Fourth Quintile	1,220,000	75	10%	
Fifth Quintile	1,220,000	75	10%	
TOTAL	**5,390,000**	**300**	**5%**	**90%**

Notes:

1. The Navigant team assumed approximately 55 percent of each utility's residential customers own their homes, a typical prerequisite for installing a solar PV system.[4] At the end of 2010, PG&E had approximately 4.5 million residential customers, SDG&E had approximately 1.1. million, and SCE had approximately 4.2 million, resulting in approximately 5.4 million homeowners. For simplicity, the Navigant team assumed those homeowners fell equally among the state's five income quintiles, with the exception of the lowest quintile.[5]
2. Assumes a coefficient of variation of 0.50

Source: Navigant team analysis.

To develop this sample frame, the Navigant team placed each ZIP code from the three IOU territories into one of four income categories based on that ZIP code's estimated median income.[6] Each of the four income categories represented one of the state's five annual income quintiles (the lowest quintile [less than $25,190/year] was omitted).[7] The team then developed its sample frame by drawing a random sample of listed landline phone numbers for owner-occupied households from within each of the four income segments across the three IOU territories (12 segments overall). Within each income segment, the team then set sample size targets in rough proportion to each IOU's share of CSI Program capacity goals, as shown in Table A-5.

[4] Federal Reserve Bank of St. Louis. 2013. "Home Ownership Rate for California." Accessed November 24, 2013. http://research.stlouisfed.org/fred2/series/CAHOWN.

[5] Calculated from EIA data (http://www.eia.gov/electricity/state/california/pdf/california.pdf) and assuming each residential customer uses about 6,300 kWh/year (http://www.eia.gov/electricity/state/california/pdf/california.pdf).

[6] U.S. Census Bureau. 2013. "Median Household Income in the Past 12 Months." 2007-2011 American Community Survey 5-year Estimates. Table B19013. Accessed November 21, 2013. http://factfinder2.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=ACS_11_5YR_B19013&prodType=table.

[7] U.S. Census Bureau. 2013. "California: Household Income Quintile Upper Limits." 2007-2011 American Community Survey 5-year Estimates. Table B19080. Accessed November 21, 2013. http://factfinder2.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=ACS_11_5YR_B19080&prodType=table.

Table A-5. Proportional Sampling Approach to Each Income Quintile

Utility	Total per Quintile
PG&E	33
SDG&E	8
SCE	34
Total	300

Source: Navigant team analysis.

A.4.6 Non-Residential Non-Participants

For the non-residential non-participant sample, the Navigant team targeted decision-makers at businesses and organizations within each of the three IOU service territories. To help ensure diversity in its sample, the Navigant team sought to include customers from each of four segments:

- Government entities
- Nonprofit organizations
- Commercial/for-profit businesses
    - Those in market sectors that have frequently participated in CSI
    - Those in market sectors that have participated less frequently

The Navigant team based its analysis of participating and non-participating market sectors on the North American Industry Classification System (NAICS) codes associated with non-residential participants in the CSI PowerClerk data. Table A-6 shows the NAICS codes included in each sample segment, as well as the additional criteria that the Navigant team applied.

Table A-6. NAICS Codes of Participating Non-Residential Customers Used to Determine Non-Participant Survey Segments

Segment	NAICS Included	Other Criteria
Government	22 – Utilities (e.g., water, electric, and gas) 48 – Transportation and Warehousing 61 – Schools and Universities 92 – Public Administration	Within IOU ZIP codes
Nonprofit	23 - Construction 62 – Health Care and Social Assistance 71 – Arts, Entertainment, and Recreation 81 – Other Services (except Public Admin.)	Within IOU ZIP codes
Commercial (High Participation)	11 – Agriculture, Forestry, Fishing, and Hunting 31 - Manufacturing 33 – Primary Metal Manufacturing 44 – Retail 45 – Sporting Goods, Hobby, Musical Instrument, and Bookstores 49 – Postal Service (incl. Warehouses and Storage)	Within IOU ZIP codes PLUS either greater than $5M revenue or more than 10 employees
Commercial (Low Participation)	All other NAICS codes	Within IOU ZIP codes PLUS either greater than $5M revenue or more than 10 employees

Source: Navigant team analysis.

The Navigant team purchased random digit dial samples for each of the four segments and sought 75 completed surveys in each segment. However, survey responses indicated that a significant number of organizations belonged to a different segment than the one indicated by the sample frame. The final disposition of surveys across the segments (with segments verified through the surveys) is presented in Table A-7.

Table A-7. Sample Disposition for Non-Residential Non-Participant Phone Surveys

Segment	Estimated Population[1]	Sample Size	Estimated Relative Precision[2]	Confidence
Government	195,000	41	13%	90%
Nonprofit	78,000	110	8%	90%
Commercial	1,027,000	154	7%	90%
TOTAL	**1,300,000**	**305**	**5.5%**	**90%**

Notes:

1. As determined by the surveys, NAICS codes provide a relatively inaccurate proxy for predicting whether a firm falls into the government, nonprofit, or for-profit market sector. The Navigant team estimated each segment's total population by applying estimated proportions to the estimated total number of non-residential customers in the three IOU territories.[8] The Navigant team used the share of employment across the three sectors as an estimate of the relative share of non-residential accounts (15% government, 6% nonprofits, and 79% for-profit businesses).
2. Assumes a coefficient of variation of 0.50

Source: Navigant team analysis.

A.4.7 Survey Data Analysis

For the participant and non-participant surveys, the Navigant team used SPSS software to clean and perform detailed statistical analysis on the data to identify trends and differences between key market segments. Open-ended responses were assigned to pre-coded response categories to enable analysis; additional response categories were defined when respondents provided responses outside the pre-coded categories.

Residential survey findings were not weighted because the sample was designed to represent the population of participants and non-participants proportionally based on their ownership type (for participants) and utility (for participants and non-participants). Non-residential participant survey findings were weighted by ownership type (host owner vs. TPO) as well as the number of projects associated with the surveyed participant based on PowerClerk data. The weighting of non-residential participant survey data ensured that the overall results were representative of the true mix of host-owned and TPO projects in the CSI population.

Non-participating non-residential survey findings were also weighted to better reflect the mix of organization types in the non-participant population. The Navigant team used employment as a proxy for number of organizations because a reliable source of information on the number of organizations in the state could not be identified. Secondary research indicates that approximately 15 percent of California employees work for government entities[9] and 6 percent work for nonprofits[10]; the remaining 79 percent are assumed to work for for-profit entities. Thus, the survey results are weighted to reflect those proportions.

[8] Calculated from EIA data (http://www.eia.gov/electricity/state/california/pdf/california.pdf) and subtracting the total estimated residential customers in Table A-5 from the total estimated customers for each IOU.

[9] http://www.labormarketinfo.edd.ca.gov/qcew/CEW-Major_NAICS.asp.

[10] http://ccss.jhu.edu/wp-content/uploads/downloads/2011/09/NED_Bulletin6_CA_2001.pdf.

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Appendix B Additional Policies Influencing the Market's Development

This appendix provides information on additional federal, state, and local policies that helped shape California's market for customer-side solar photovoltaic (PV). The Navigant Consulting, Inc. (Navigant) team's interviews with solar PV market actors indicated that each of these policies did in fact contribute to the market's development (as described in this section), but that they were not as central to the market as the key policies described in Section 2.2 of the main body of this report.

B.1 Federal Policies

This section describes the U.S. Department of Energy's (DOE's) Solar Rooftop Challenge Grant program.

B.1.1 DOE Solar Rooftop Challenge Grants

The DOE Solar Rooftop Challenge Grant program is a component of the SunShot Initiative. The SunShot Initiative seeks to drive adoption of solar PV by addressing cost barriers relating to the project "soft costs," including permitting, financing options, planning and zoning, as well as net metering and standards for interconnecting systems.

Currently, there are 22 teams across the United States that are involved in deploying innovative ideas around solar PV system costs. DOE recently issued a second round of funding for a total of $24 million to be spent on unique, innovative approaches to transforming the market.

The 22 teams span 19 states, including most of the West and the Southwest of the United States, covering a combined population of about 47 million people.[11,12] The financial barriers these potential customers face do not come only from the cost of technology; soft costs can account for up to 40 percent of the total cost of installed customer-side PV systems.[13] The Rooftop Solar Challenge participants are tackling these barriers from multiple angles including leverage teams consisting of city, county, and state officials, regulatory entities, private industry, universities, local utilities, and other regional stakeholders. Examples of the initiatives these teams are working on include implementing an online permitting system and standardizing permitting procedures.

It is not clear whether DOE will issue another round of funding for more participants to join or to expand the scope of the Rooftop Solar Challenge. At the moment, project teams are working on implementing their innovations and reporting best practices to the broader industry.

B.2 California State Policies and Regulations

This section describes three types of state-level policies and regulations that have influenced the California market for customer-side solar PV:

[11] http://www.eere.energy.gov/solarchallenge/.
[12] http://energy.gov/maps/sunshot-rooftop-solar-challenge.
[13] http://energy.gov/articles/doe-awards-12-million-spur-rapid-adoption-solar-energy-rooftop-solar-challenge.

- Loading order
- Renewable portfolio standard (RPS)
- Solar PV incentive programs besides the CSI Program

B.2.1 Loading Order

The California Public Utilities Commission (CPUC) gives direction to the California Independent System Operator (CAISO) as to which resources have highest priority of use among the entire population of eligible generating resources. The guidance provided by the CPUC helps to guarantee adequate delivery of power, including the appropriate level of ancillary services, while still reaching the state's energy efficiency and greenhouse gas reduction goals.

The CPUC has mandated that CAISO prioritize cost-effective energy efficiency and demand response measures first and renewable energy second. The role of fossil fuel resources is to fill the gap left unmet by other resources. Computerized selection of a market clearing price assures consumer price protection.

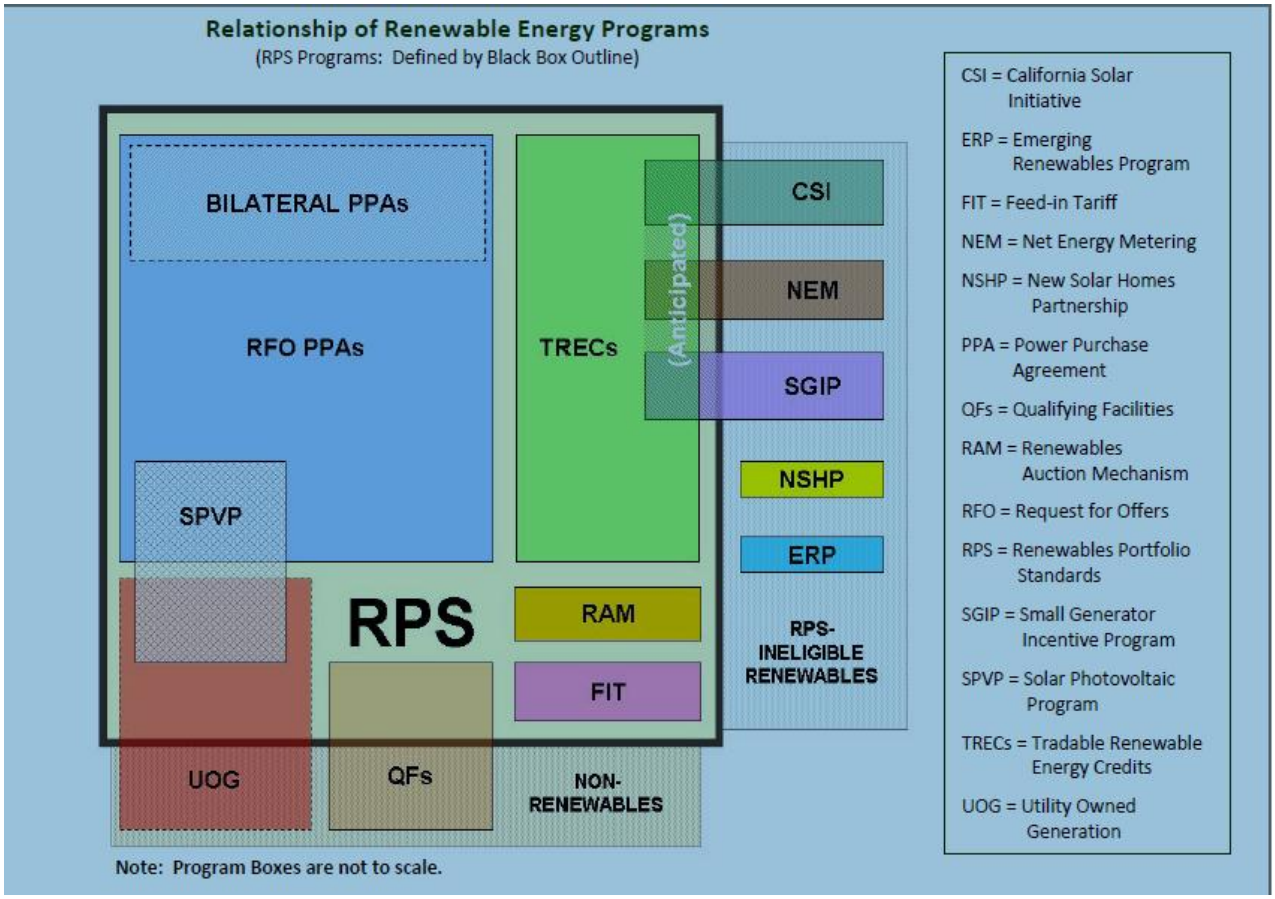
B.2.2 Renewable Portfolio Standard

The state legislature passed the California RPS in 2002, and it was amended in 2006 and 2011. Ultimately, all investor-owned utilities (IOUs) and publicly owned utilities (POUs) are responsible for having 33 percent of their retail sales derived from eligible renewable energy resources. For RPS compliance, utilities must establish a preference for bundled electricity, which must ultimately represent 75 percent of their renewable supply by 2017.[14]

[14] Renewable Jungle. January 31. 2012.

The RPS is the foundation of the renewable energy policy in California and has set targets that have encouraged market and policy innovation in support of renewables technologies. Most of the renewable energy that contributes to the RPS comes from large-scale renewable projects, in other words, those ranging from 2 megawatts (MW) to 1,000 MW. But the RPS also complements many other programs operating across California that contribute to the development of small-scale projects, those that primarily serve their own on-site load. The entire menu of renewable policies in California creates opportunities for both small-scale and large-scale projects to contribute to utilities' RPS compliance. Figure B-1 provides a look at the relationship of the RPS to other renewable energy-focused programs.

Figure B-1. Relationship of Renewable Energy Programs



Source: The Renewable Jungle.

As the RPS inherently overlaps with many other state and federal programs, the future of the RPS likely means adaptations will ensue as the compliance date approaches in 2020. The impacts of potential penalties for non-compliance are not well understood. A great number of market challenges persist, including the need for further cost declines. Thus, future strategies and renewable programs that will overlap with the RPS will need to focus on mounting pressures on retail electricity rates and costs to customers.

B.2.3 Solar PV Incentive Programs

Several state-based programs may provide incentives for solar PV installations in California. They are briefly described here.

- **Self-Generation Incentive Program (SGIP):** The SGIP is one of the longest-running renewable incentive programs in California and across the United States. Programming started in 2001 with a focus on peak-load reduction and evolved to provide incentives for many different renewable technologies. CSI assumed the incentives for solar PV power in 2006.

  The program is considered a success, influencing the installation of several hundred MW of renewable energy capacity.[15] The program has continued to evolve since its inception in the early 2000s in response to different market signals. While the CSI Program assumed the customer-side PV incentives, SGIP has also added energy storage technologies to its menu of eligible technologies. Likewise, the SGIP has started to focus on larger distributed projects and now includes a 20 percent bonus for systems incorporating products manufactured in California. Program funding will continue through December 2015 with an annual statewide budget of more than $74 million.

- **Feed-In Tariffs (FITs) for Projects Greater Than 1 MW:** The California legislature has amended the state's FIT legislation several times and it is still in the process of being implemented across the entire state. Amendments made in 2009 and 2011 restructured the payment mechanism, granting more flexibility to utilities to determine the price paid to end users for power taken by the grid. While all IOUs and publicly owned utilities with more than 75,000 customers are required to have a FIT program in place, publicly owned utilities are still in the process of implementing such programs. All publicly owned utilities were required to develop FIT programs by June 1, 2013. As of the end of 2012, the existing FIT MW allocation was 494 MW, of which 348 MW were subscribed.[16]

  The FIT programs are beneficial to the targets prescribed by the California RPS by encouraging customers to adopt on-site solar PV systems by offering payments for power they generate for the grid. The FITs will be available until the combined statewide cumulative capacity of eligible generation equals 750 MW, with each utility contributing a certain portion to this total.

  As of July 24, 2013, the Assembly Bill (AB) 1969 FIT program is closed. Senate Bill (SB) 32 FIT is the replacement and uses the renewable market adjusting tariff, granting the utilities more flexibility in determining the price for FITs. The first program period under the new legislation will begin in November 2013.[17] Program expansion is also currently underway, as publicly owned utilities move toward compliance with the legislation. Future program expansion is likely to be based on how the solar PV market in California continues to mature.

  There is a debate around whether or not FITs are appropriate or beneficial to the California market. While several other global solar PV markets – most notably Germany's and Japan's –

[15] http://www.cpuc.ca.gov/PUC/energy/DistGen/sgip/aboutsgip.htm.
[16] Renewables Portfolio Standard Quarterly Report 3rd and 4th Quarter 2012. California Public Utility Commission, page 14.
[17] http://www.cpuc.ca.gov/PUC/energy/Renewables/hot/feedintariffs.htm.

have seen significant benefits from FIT policies, some argue that net metering is more appropriate for the California market in order to encourage customers to consume power on-site.

- **Emerging Renewables Program (ERP):** The goal of the ERP was to contribute to developing a self-sustaining market for new renewable technologies by stimulating demand for them. The program originally provided rebates and production incentives to cover the high upfront costs of renewable project development. The initial allocation was $54 million starting in 1998. The program design favors small generating systems.

  The program was temporarily suspended in March 2011 and is currently being officially closed out. Program administrators will process applications received before July 27, 2012, but will no longer accept new applications.

- **California Solar Initiative (IOU programs, CSI Research, Development, and Deployment [RD&D]):** The California Solar Initiative Program began in 2006 with the goal of supporting RD&D of solar PV technologies in California. With a budget of $2.367 billion allocated over ten years, the CSI Program supports a broad range of activities to diminish the barriers to solar PV adoption. CSI provides financial and informational support to business development, technology development, and systems integration efforts in the California solar PV market. In addition to the resources allocated to the CSI Program from the CPUC, the program works with complementary programs such as New Solar Homes to develop a robust market for solar PV through the Go Solar Campaign.[18] The CSI Program also complements many of the various incentives and informational programs offered by California utilities.

  The CSI Program established the goal of installing 1,940 MW of solar PV in California by 2016 by influencing near-term market transformation on both the supply and demand sides of the market. Solar PV customers receive incentives based on the performance of their solar PV system. Solar developers, technology providers, and financial companies benefit from the CSI Program's extensive market research support. To date, the CSI Program has experienced notable success towards these goals. The CSI Program has contributed significantly to the expansion of distributed solar PV systems in California.[19]

  The future of the solar PV distributed generation market depends on the speed with which it can become self-sustaining. The CSI Program aims to support the market by driving demand for solar PV systems until incentives are no longer necessary to support the market. The CPUC closely monitors the growth of the solar PV market as it relates to the future of the CSI Program.

- **Other Elements of SB 1 (POU Programs, New Solar Homes Partnership):** Governor Arnold Schwarzenegger signed SB 1 in 2006. SB 1 addresses multiple sectors across the state of California, including entities not under CPUC authority. SB 1 has segmented targets and

[18] Go Solar California, *About the California Solar Initiative,* Accessed: September 2013: http://www.gosolarcalifornia.ca.gov/about/csi.php.

[19] In 2011, 54 percent of CSI applications were for third-party-owned rooftop solar PV systems. Jeremy Carl et al. Stanford University – Hoover Institution. *Renewable and Distributed Power in California: Simplifying the Regulatory Maze – Making the Path for the Future*.

incentives to address these different market sectors; for example, POUs must install 700 MW of new solar PV capacity. POUs are responsible for implementing their own programs to achieve these goals without the support of the CPUC.[20] POUs such as the Sacramento Municipal Utility District and the Los Angeles Department of Water and Power administer their own incentive and unique financing programs (e.g., feed-in tariffs) in support of these solar PV targets.

In addition, the California Energy Commission (CEC) administers unique programs to encourage broad market growth beyond the markets targeted by CPUC's CSI Program or the POU incentive efforts. For example, CEC administers the CSI New Solar Homes Partnership (NSHP) to provide incentives for solar PV on new residential construction, which are not eligible for the CSI Program. To be eligible for the NSHP incentives, the home must receive electricity from one of the following investor-owned utilities: Pacific Gas and Electric Company (PG&E), Southern California Edison (SCE), San Diego Gas & Electric Company (SDG&E), and Bear Valley Electric. Launched in 2007, the NSHP provides incentives to market-rate and affordable single-family and multifamily housing for solar PV systems. NSHP goals include installing 400 MW of solar PV electric capacity on new homes. NSHP also aims to have solar PV electric systems on 50 percent of all new homes built in California by the end of 2016.[21]

B.3 Local Policies and Programs

This subsection describes the effect of locally implemented Property-Assessed Clean Energy (PACE) finance programs on the California market for customer-side solar PV.

Innovative financing structures continue to be the source of much research across the solar PV industry and California has consistently been an early adopter of new financing mechanisms that support the adoption of solar PV systems. The high financial barriers to the adoption of solar PV systems have consistently thwarted market demand in California and across the United States. Concurrently, California has consistently supported the use of innovative financing mechanisms, which have opened many customer segments to solar PV ownership or leasing that previously could not overcome the high upfront costs.

PACE programs allow property owners to borrow money for energy improvement projects that are repaid through their property taxes. A number of energy efficiency and renewable energy technologies can be financed through PACE programs, including solar PV.

PACE financing was first adopted in California through the passage of AB 811, permitting municipalities to leverage special energy districts to provide financial support to install distributed solar PV systems. PACE financing originated in Berkeley, California, and Berkeley and Palm Desert were the first adopters of PACE financing in the United States.

California now hosts many PACE financing programs at the municipal and regional levels, allowing residential and non-residential customers the ability to circumvent high upfront solar PV system costs.

[20] http://www.gosolarcalifornia.ca.gov/documents/CSI_HANDBOOK.PDF.
[21] http://www.dsireusa.org/incentives/incentive.cfm?Incentive_Code=CA150F&re=0&ee=0.

In 2012, California launched a major PACE initiative that incorporates property owners in 126 cities and 14 counties.[22]

California's investor-owned and publicly owned utilities also support unique financing programs that support their customers. For example, SDG&E supports on-bill financing for solar PV systems in its service territory.

The Federal Housing Finance Authority (FHFA), which disputes the senior liens placed on properties through PACE programs, may be a challenge for PACE financing for residential customers in the future. FHFA asserts that PACE alters traditional lending priorities and amount to an alteration of long-standing mortgage lending practices. FHFA opposition has minimized PACE market penetration. Non-residential PACE financing does not face the same challenges, as the FHFA does not typically underwrite commercial mortgages.

There are risks involved with adopting new financing mechanisms, but as the PACE financing concept continues to demonstrate success it is likely that many more regional development authorities and municipalities will see the value in deploying such a program in support of clean energy goals. While momentum is still building behind PACE financing, there is optimism around the potential for commercial projects to leverage PACE financing structures with success.

[22] http://www.dsireusa.org/solar/solarpolicyguide/?id=26.

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Appendix C Upstream Market Characterization: Supplemental Information

This appendix provides supplemental information related to the upstream market characterization in Section 2.3 of the main report. In particular, it provides estimated market share information of the top 20 firms in several market actor categories (subsection C.1), estimated CSI market share information for installation contractors (subsection C.2), and market share information for manufacturers of PV modules and inverters (subsection C.3).

C.1 Estimated Market Share of Top 20 Firms Based on CSI Installations

This subsection provides estimates of annual market share information based on the Navigant team's analysis of the CSI PowerClerk data. It includes estimates for the annual share of incremental California Solar Initiative (CSI) capacity installed for the Top 20 solar photovoltaic (PV) installation contractors (based on 2012 data) for both host-owned and third-party-owned (TPO) systems, as well as estimates for each solar PV finance company's share of TPO system ownership for the period 2007–2012.[23] The data is presented separately for the residential and non-residential sectors in the following tables.

Table C-1. Solar PV Installation Contractor Tables

Table Number	Table Title
C-2	Market Share of Annual CSI Capacity Additions – Solar PV Installation Contractors (Residential Host-Owned Systems)
C-3	Market Share of Annual CSI Capacity Additions – Solar PV Installation Contractors (Residential TPO Systems)
C-4	Market Share of Annual CSI Capacity Additions – Solar PV Finance Companies Associated with Listed System Owner (Residential TPO Systems)
C-5	Market Share of Annual CSI Capacity Additions – Solar PV Installation Contractors (Non-Residential Host-Owned Systems)
C-6	Market Share of Annual CSI Capacity Additions – Solar PV Installation Contractors (Non-Residential TPO Systems)
C-7	Market Share of Annual CSI Capacity Additions – Solar PV Finance Companies Associated with Listed System Owner (Non-Residential TPO Systems)

Readers should note that these estimates only include systems that have received a CSI incentive. As noted in Section 5 of the main report, there are an increasing number of systems being installed without incentives.

[23] See Appendix A, Subsection A.1 (Assumptions for Supply-Chain Assessment) for an explanation of how the Navigant team determined solar PV finance company affiliations with various projects and listed system owner firms.

Table C-2. Market Share of Annual CSI Capacity Additions – Solar PV Installation Contractors (Residential Host-Owned Systems)

Rank	Company Name	2007	2008	2009	2010	2011	2012
1	Energy Savers	0.0 %	0.1 %	0.5 %	1.1 %	2.5 %	5.2 %
2	Self-Install	1.0 %	2.2 %	2.3 %	2.6 %	2.7 %	4.2 %
3	REC Solar, Inc.	9.9 %	6.1 %	9.3 %	4.8 %	4.1 %	3.1 %
4	Shorebreak Energy Developers	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %	2.6 %
5	Galkos Construction Inc.	0.0 %	0.0 %	0.0 %	0.6 %	3.4 %	2.4 %
6	Real Goods Solar	8.2 %	7.4 %	5.6 %	3.7 %	4.1 %	1.9 %
7	Solar Universe	0.0 %	0.0 %	0.7 %	1.6 %	1.4 %	1.8 %
8	The Solar Company	0.6 %	0.7 %	1.1 %	1.7 %	2.6 %	1.6 %
9	Smart Energy USA	0.0 %	0.0 %	0.0 %	0.1 %	0.7 %	1.3 %
10	A1 Solar Power Inc. (Hot Solar)	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %	1.2 %
11	SolarCity	7.8 %	7.1 %	3.9 %	1.6 %	1.4 %	1.2 %
12	Solaire Energy Systems	0.0 %	0.0 %	0.1 %	0.5 %	1.1 %	1.2 %
13	Horizon Solar Power	0.0 %	0.0 %	0.0 %	0.2 %	0.5 %	1.1 %
14	Advanced Solar Electric, Inc.	2.4 %	1.7 %	1.2 %	1.1 %	1.2 %	1.1 %
15	Elite Electric	0.0 %	0.0 %	0.0 %	0.2 %	0.7 %	1.0 %
16	Solare Energy, Inc.	0.0 %	0.0 %	0.0 %	0.3 %	0.5 %	0.9 %
17	Sullivan Solar Power	0.8 %	0.8 %	1.1 %	1.5 %	1.1 %	0.9 %
18	Bland Solar and Air, Inc.	0.2 %	0.3 %	0.4 %	0.5 %	0.6 %	0.9 %
19	Diablo Solar Services, Inc.	0.4 %	0.4 %	1.0 %	0.6 %	0.5 %	0.8 %
20	Clean Solar Inc.	0.1 %	0.1 %	0.3 %	0.5 %	0.6 %	0.8 %
21	Remaining Market Share	68.6 %	73.1 %	72.6 %	77.1 %	70.5 %	65.0 %

Note: Sorted by 2012 market share.

Source: Navigant team analysis of PowerClerk database extract through December 31, 2012.

Table C-3. Market Share of Annual CSI Capacity Additions – Solar PV Installation Contractors (Residential TPO Systems)

Rank	Company Name	2007	2008	2009	2010	2011	2012
1	SolarCity	4.6 %	48.3 %	51.9 %	20.2 %	30.4 %	20.5 %
2	Verengo	0.0 %	0.0 %	2.1 %	10.5 %	12.1 %	15.4 %
3	Petersen-Dean	0.2 %	0.0 %	1.7 %	6.9 %	9.5 %	4.9 %
4	REC Solar, Inc.	8.6 %	15.8 %	16.9 %	13.0 %	6.3 %	4.8 %
5	Sungevity, Inc.	0.0 %	0.1 %	0.1 %	4.2 %	7.0 %	4.0 %
6	American Solar Direct	0.0 %	0.0 %	0.0 %	0.9 %	2.4 %	2.6 %
7	Real Goods Solar	5.0 %	0.8 %	5.9 %	14.0 %	10.9 %	2.6 %
8	Energy Efficiency Solar, Inc.	3.2 %	0.0 %	0.0 %	3.0 %	3.1 %	2.5 %
9	Sullivan Solar Power	0.5 %	0.0 %	0.0 %	0.0 %	0.7 %	2.0 %
10	Solar West Electric, Inc.	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %	1.6 %
11	Solar Universe	0.0 %	0.0 %	0.0 %	0.0 %	0.2 %	1.6 %
12	Solar Service Center	0.0 %	0.0 %	0.0 %	2.1 %	2.6 %	1.6 %
13	HelioPower, Inc.	3.0 %	0.3 %	0.1 %	3.3 %	3.2 %	1.5 %
14	The Solar Company	0.6 %	0.0 %	0.0 %	0.0 %	0.2 %	1.4 %
15	Galkos Construction Inc.	0.0 %	0.0 %	0.0 %	0.0 %	0.7 %	1.3 %
16	Baker Electric Solar	0.0 %	0.0 %	0.1 %	0.0 %	0.0 %	1.2 %
17	Elite Electric	0.0 %	0.0 %	0.0 %	0.0 %	0.2 %	1.2 %
18	Sky Power Systems	0.0 %	0.0 %	0.0 %	0.1 %	0.1 %	0.7 %
19	Fralick Homes	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %	0.7 %
20	Arise Solar	0.3 %	0.0 %	0.0 %	0.0 %	0.1 %	0.7 %
21	Remaining Market Share	74.0 %	34.8 %	21.3 %	21.8 %	10.2 %	27.5 %

Note: Sorted by 2012 market share

Source: Navigant team analysis of PowerClerk database extract through December 31, 2012.

Table C-4. Market Share of Annual CSI Capacity Additions – Solar PV Finance Companies Associated with Listed System Owner (Residential TPO Systems)

Rank	Company Name	2007	2008	2009	2010	2011	2012
1	Sunrun	0.3 %	30.3 %	40.7 %	68.0 %	46.0 %	29.2 %
2	SunPower	0.0 %	0.0 %	0.0 %	0.1 %	3.5 %	26.3 %
3	SolarCity	0.0 %	44.9 %	51.2 %	20.2 %	30.0 %	20.4 %
4	Clean Power Finance	0.0 %	0.0 %	0.0 %	0.0 %	4.3 %	8.3 %
5	NRG Energy	0.0 %	0.0 %	0.0 %	0.0 %	0.4 %	5.0 %
6	Sungevity	0.0 %	0.1 %	0.0 %	3.8 %	6.8 %	4.0 %
7	American Solar Direct/ASD Solar	0.0 %	0.0 %	0.0 %	0.9 %	2.4 %	2.6 %
8	White Start Solar Leasing/Sun Manager	0.0 %	0.0 %	0.0 %	0.3 %	2.4 %	1.6 %
9	Raydius Energy	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %	0.6 %
10	[Blank]	30.7 %	14.0 %	5.7 %	2.4 %	1.7 %	0.6 %
11	One Roof Energy, Inc.	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %	0.4 %
12	SunEdison	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %	0.2 %
13	Barnes Solar Inc.	0.0 %	0.0 %	0.0 %	0.1 %	0.1 %	0.1 %
14	Bright Grid Development Company	0.0 %	0.0 %	0.0 %	0.0 %	0.1 %	0.1 %
15	A1 Solar Power Inc. (Hot Solar)	0.0 %	0.0 %	0.0 %	0.2 %	0.6 %	0.1 %
16	Brite Lease	0.0 %	0.0 %	0.0 %	0.0 %	0.2 %	0.1 %
17	Renewable Asset Management Company, LLC	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %	0.1 %
18	Pala Band of Mission Indians	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %
19	Apex Solar	0.0 %	0.0 %	0.0 %	0.0 %	0.2 %	0.0 %
20	Concord Family Apartments, L.P.	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %
21	Remaining Market Share	69.0 %	10.7 %	2.4 %	4.1 %	1.3 %	0.4 %

Note: Sorted by 2012 market share

Source: Navigant team analysis of PowerClerk database extract through December 31, 2012.

Table C-4 resulted from Navigant Consulting, Inc. (Navigant) reassigning special purpose entities (SPEs) to various firms using data available in PowerClerk (i.e., system owner applicant name). Navigant team staff reviewed the names of the SPEs (many of which were derivative of the applicant corporate name) and reassigned accordingly.

Table C-5. Market Share of Annual CSI Capacity Additions – Solar PV Installation Contractors (Non-Residential Host-Owned Systems)

Rank	Company Name	2007	2008	2009	2010	2011	2012
1	SunPower	0.0 %	8.5 %	21.9 %	6.8 %	4.0 %	26.4 %
2	Chevron Energy Solutions	0.0 %	0.0 %	5.9 %	12.9 %	13.5 %	9.2 %
3	SolarCity	1.9 %	3.8 %	1.5 %	0.7 %	0.7 %	5.6 %
4	SPG Solar, Inc.	4.7 %	6.1 %	15.6 %	7.6 %	6.4 %	4.9 %
5	Stronghold Engineering, Inc.	0.0 %	0.0 %	0.0 %	0.5 %	0.7 %	4.1 %
6	Cupertino Electric, Inc.	0.0 %	1.1 %	1.5 %	1.8 %	3.1 %	2.5 %
7	JKB Development Inc.	0.0 %	1.1 %	0.0 %	1.9 %	0.3 %	2.5 %
8	REC Solar, Inc.	4.5 %	11.3 %	5.3 %	9.2 %	7.0 %	2.1 %
9	Chico Electric	0.0 %	4.5 %	2.4 %	1.3 %	0.8 %	2.0 %
10	BAP Power Corporation	0.0 %	0.0 %	1.3 %	6.4 %	4.4 %	1.9 %
11	Don Pickett & Associates, Inc.	0.0 %	0.0 %	0.0 %	0.1 %	0.0 %	1.7 %
12	Borrego Solar Systems, Inc.	0.1 %	2.8 %	3.0 %	0.8 %	0.8 %	1.5 %
13	Conergy, Inc.	0.2 %	6.4 %	2.3 %	0.6 %	0.2 %	1.4 %
14	Self-Install	0.0 %	1.3 %	0.4 %	0.2 %	1.1 %	1.4 %
15	Sullivan Solar Power	0.0 %	0.4 %	0.6 %	0.4 %	0.2 %	1.4 %
16	ROEBBELEN CONTRACTING INC	0.0 %	0.0 %	0.0 %	0.0 %	0.6 %	1.2 %
17	Rosendin Electric Inc.	0.0 %	0.0 %	0.0 %	0.0 %	1.1 %	1.1 %
18	Stellar Energy GP	0.8 %	0.0 %	0.0 %	0.0 %	8.1 %	1.0 %
19	Vista Solar, Inc.	0.0 %	0.0 %	0.0 %	0.2 %	0.3 %	0.9 %
20	Premier Power Renewable Energy, Inc.	0.0 %	1.1 %	4.3 %	0.0 %	1.8 %	0.9 %
21	Remaining Market Share	87.8 %	51.6 %	34.1 %	48.6 %	45.2 %	26.3 %

Note: Sorted by 2012 market share.

Source: Navigant team analysis of PowerClerk database extract through December 31, 2012.

.Table C-6. Market Share of Annual CSI Capacity Additions – Solar PV Installation Contractors (Non-Residential TPO Systems)

Rank	Company Name	2007	2008	2009	2010	2011	2012
1	SolarCity	0.0 %	1.1 %	2.6 %	3.3 %	24.9 %	22.8 %
2	SunEdison	24.6 %	17.4 %	14.2 %	17.6 %	7.3 %	22.0 %
3	PFMG Construction, Ltd	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %	10.3 %
4	Rosendin Electric Inc.	0.0 %	0.0 %	0.0 %	0.0 %	14.6 %	6.0 %
5	Borrego Solar Systems, Inc.	0.1 %	1.4 %	2.9 %	0.0 %	9.8 %	5.3 %
6	Johnson Controls	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %	4.3 %
7	SunPower	29.4 %	16.7 %	36.8 %	0.3 %	4.4 %	3.3 %
8	Conergy, Inc.	0.0 %	5.2 %	0.6 %	5.3 %	1.1 %	2.1 %
9	Enfinity America Corporation	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %	1.8 %
10	EcoPlexus, Inc.	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %	1.7 %
11	SPG Solar, Inc.	0.1 %	3.7 %	4.6 %	12.6 %	2.5 %	1.5 %
12	REC Solar, Inc.	0.3 %	2.8 %	1.9 %	4.9 %	1.6 %	1.5 %
13	Sun Edison LLC	36.9 %	12.7 %	1.6 %	0.0 %	1.0 %	1.3 %
14	Stellar Energy GP	0.0 %	0.0 %	6.0 %	0.0 %	0.0 %	1.3 %
15	Taber Construction Inc.	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %	1.2 %
16	Shanks Electric Corporation	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %	1.1 %
17	BAP Power Corporation	0.0 %	0.0 %	0.0 %	2.2 %	0.7 %	1.0 %
18	Pacific Power Renewables, Inc.	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %	1.0 %
19	BELECTRIC INC	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %	1.0 %
20	Bright Power Inc.	0.0 %	0.0 %	0.0 %	5.4 %	0.0 %	0.9 %
21	Remaining Market Share	8.7 %	39.1 %	29.0 %	48.5 %	32.0 %	8.8 %

Note: Sorted by 2012 market share.

Source: Navigant team analysis of PowerClerk database extract through December 31, 2012.

Table C-7. Market Share of Annual CSI Capacity Additions – Solar PV Finance Companies Associated with Listed System Owner (Non-Residential TPO Systems)

Rank	Company Name	2007	2008	2009	2010	2011	2012
1	SunEdison	61.4 %	31.8 %	17.7 %	27.2 %	11.1 %	23.7 %
2	SolarCity	0.0 %	0.0 %	2.6 %	3.3 %	25.0 %	22.6 %
3	HSD Solar Holdings, LLC	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %	6.5 %
4	Wells Fargo Bank Northwest	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %	5.7 %
5	Green Lake Capital	0.0 %	0.0 %	0.0 %	0.0 %	9.8 %	4.6 %
6	SunPower	29.4 %	9.7 %	32.2 %	0.0 %	2.7 %	4.5 %
7	Tioga Energy	0.0 %	0.4 %	0.5 %	0.8 %	1.4 %	4.4 %
8	Enfinity	0.0 %	0.0 %	0.0 %	2.5 %	1.1 %	3.8 %
9	NRG Energy	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %	3.2 %
10	ISH Solar CA, LLC	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %	1.7 %
11	Main Street Power Company, Inc.	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %	1.2 %
12	Sundurance Barstow LLC	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %	1.1 %
13	Lightstorm Technologies, Inc.	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %	1.0 %
14	Olivehurst Solar, LLC	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %	1.0 %
15	Environmental Security Technology Certification Program	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %	1.0 %
16	PsomasFMG, LLC	0.0 %	0.0 %	0.0 %	0.0 %	11.4 %	0.9 %
17	TGU City of Escondido Solar LLC	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %	0.9 %
18	Central Valley Solar, LLC	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %	0.8 %
19	Belvedere Equipment Finance	7.6 %	0.8 %	0.7 %	0.0 %	0.1 %	0.8 %
20	GASNA 5P LLC	0.0 %	0.0 %	0.0 %	0.0 %	0.0 %	0.8 %
21	Remaining Market Share	1.6 %	57.4 %	46.3 %	66.2 %	37.4 %	9.8 %

Note: Sorted by 2012 market share.

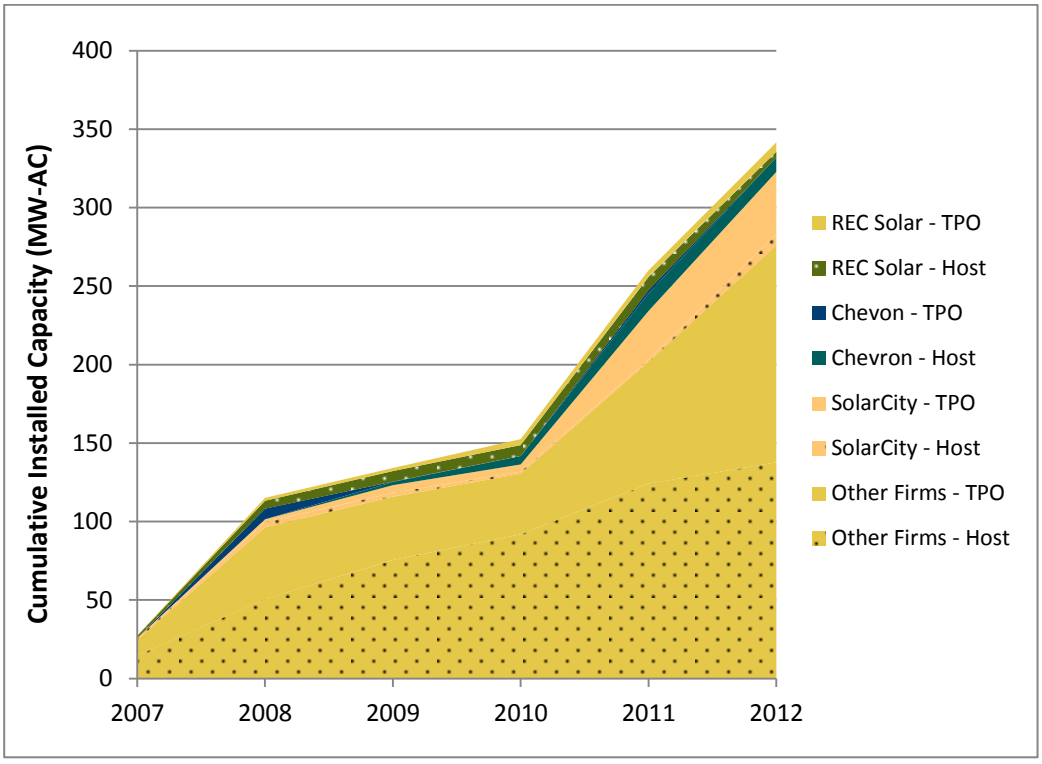
Source: Navigant team analysis of PowerClerk database extract through December 31, 2012.

Table C-7 resulted from the Navigant team reassigning SPEs to various firms using data available in PowerClerk (i.e., system owner applicant name).

C.2 Installation Contractor Market

Figure C-1 presents the overall growth in capacity of the California solar PV market from 2007 through 2012 and illustrates the portion of that market that was captured by the top three installation contractors – Solar City, Chevron Energy Systems, and REC Solar – versus the portion captured by all other installation contractor firms. In the figure, all "other" installation contractor firms are grouped together in the section in orange, with solid orange representing capacity owned by a third party and light spotted orange representing host-owned installed capacity. The same color scheme is used for the top three firms as well: solid color sections represent TPO installations and light spotted color represents host-owned capacity installations.

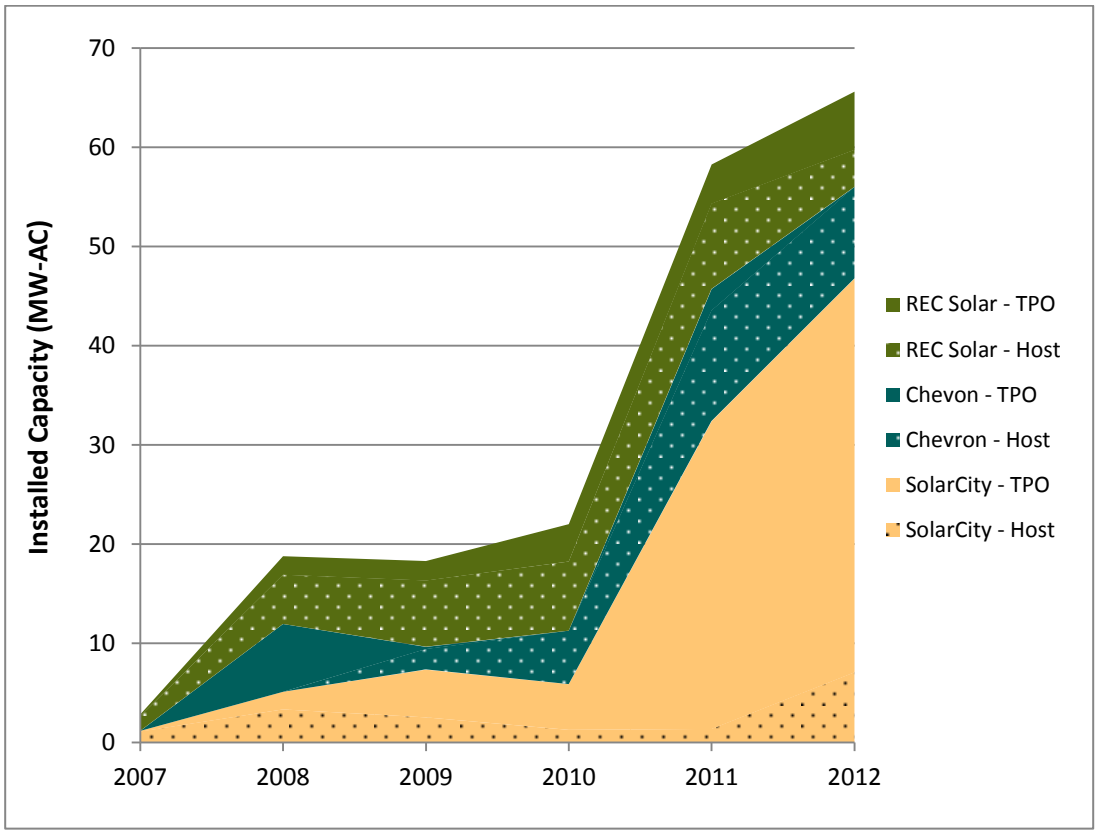
Figure C-1. Cumulative Capacity Installed by Top Three and Other Installation Contractors in California



Source: Navigant team analysis of PowerClerk database extract through December 31, 2012.

Figure C-2 takes a closer look at the portion of overall installed capacity captured by the top three installation contractor firms – Solar City, Chevron, and REC Solar – to more clearly show their share of the market and to show each firm's breakdown of host-owned and TPO capacity installed over time. While REC Solar and Chevron have installed a higher proportion of host-owned systems within their firms' installed capacity portfolio, SolarCity primarily installs TPO systems.

Figure C-2. Annual CSI Capacity Installed by Top Three Installation Contractors in California

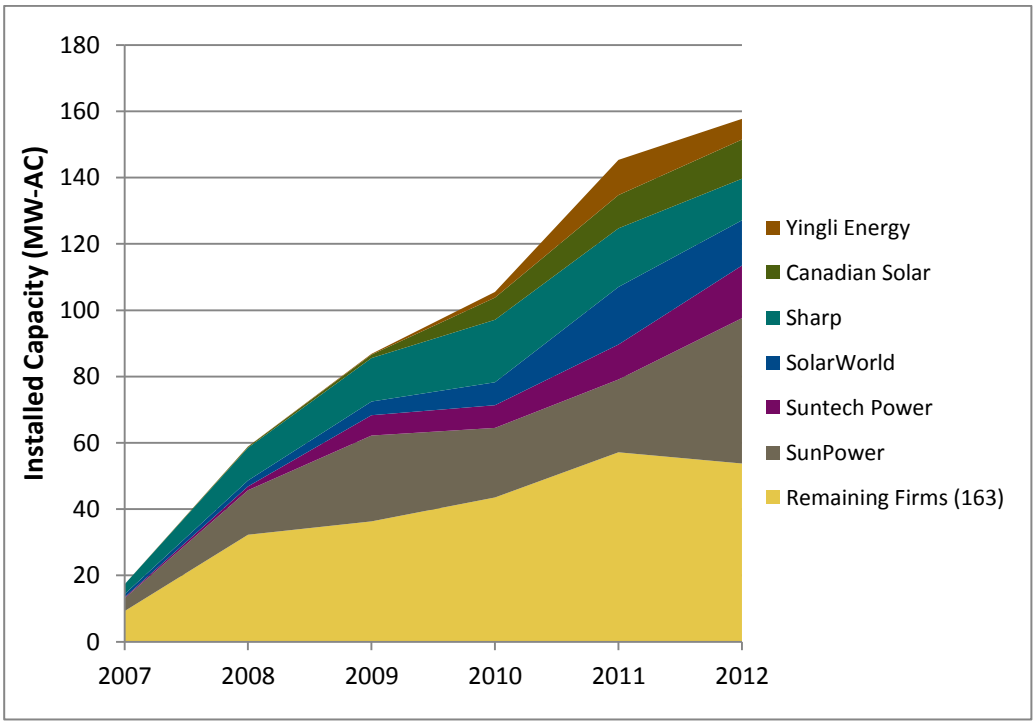


Source: Navigant team analysis of PowerClerk database extract through December 31, 2012.

C.3 Manufacturer Share of Host-Owned Market

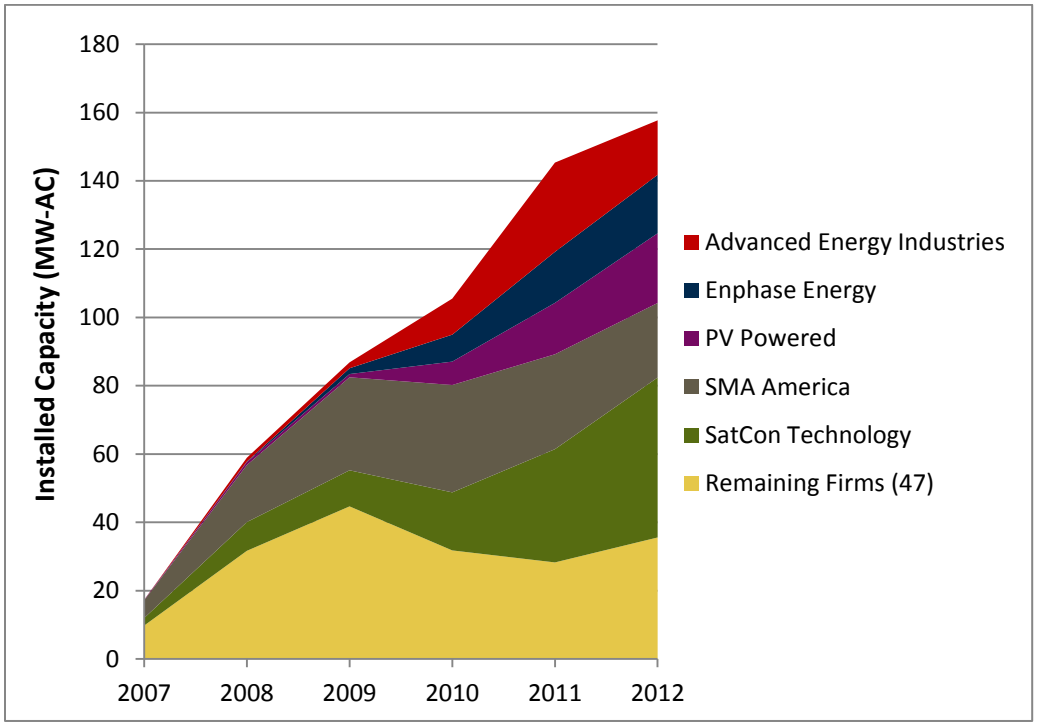
Figure C-3 and Figure C-4 describe the overall market share captured by leading PV module and inverter manufacturing firms, respectively, from 2007 to 2012. For both products, the figures suggest that as the market for host-owned systems has progressed, the number of firms that share a significant portion of the market (5 percent or greater) has increased, creating a more diffuse and competitive marketplace for modules and inverters.

Figure C-3. PV Module Manufacturer Market Share of Annual Host-Owned Capacity Additions



Source: Navigant team analysis of PowerClerk database extract through December 31, 2012.

Figure C-4. Inverter Manufacturer Market Share of Annual Host-Owned Capacity Additions



Source: Navigant team analysis of PowerClerk database extract through December 31, 2012.

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Appendix D Detailed Analysis of Market Transformation Indicators

Given the number of Market Transformation Indicators (MTIs) and the amount of data that the Navigant Consulting, Inc. (Navigant) team analyzed, the main body of the report focused only on summary-level findings for each indicator. This appendix provides additional detail on the analysis and results related to each of the MTIs that was omitted from Sections 4 and 5 of the main report. The order and discussion on each MTI mirrors that found in the main report and includes each of the following subsections:

- Description of the MTI
- What this indicator tells us about the market
- Key findings
- Suggestions for future tracking
- Data sources

D.1 Indicators of Progress Toward Intermediate Outcomes

The MTIs presented in this section measure the market's progress toward the intermediate outcomes that the California Solar Initiative (CSI) intended to achieve. The MTIs indicate progress toward achieving the changes in market structure or market actor behavior that CSI intended roughly two to three years after the program started. The remainder of this section presents a summary of progress toward each of the three intermediate outcomes that CSI sought to achieve:

- Reduced first and maintenance cost to customers
- An increase in customer confidence in qualifying equipment
- An expanded and enhanced supply chain

D.1.1 Reduced First and Maintenance Cost to Customers

High first costs and maintenance costs have long been associated with customer-side solar PV. To assess market transformation in regard to this barrier, the Navigant team analyzed the presence of the following three MTIs:

- Total system costs for host-owned systems declines
- Volume ($) of projects financed through standardized financial products increases
- Total idle time declines

The remainder of this subsection focuses on detailed findings for these three MTIs.

D.1.1.1 Indicator: Declining Total System Costs for Host-Owned Systems

Description of MTI

The Navigant team used the CSI PowerClerk database to analyze the reported median total cost for installed, host-owned PV systems over time. The analysis disaggregated residential and non-residential systems, and the Navigant team examined trends at both quarterly and annual increments. Much of the system cost analysis for this study excluded third-party-owned (TPO) systems due to the inconsistency in reporting methods used for TPO system costs. The team inflated the reported total system costs in the PowerClerk data to December 2012 dollars using the Consumer Price Index (CPI) for California.[24]

What this Indicator Tells Us About the Market

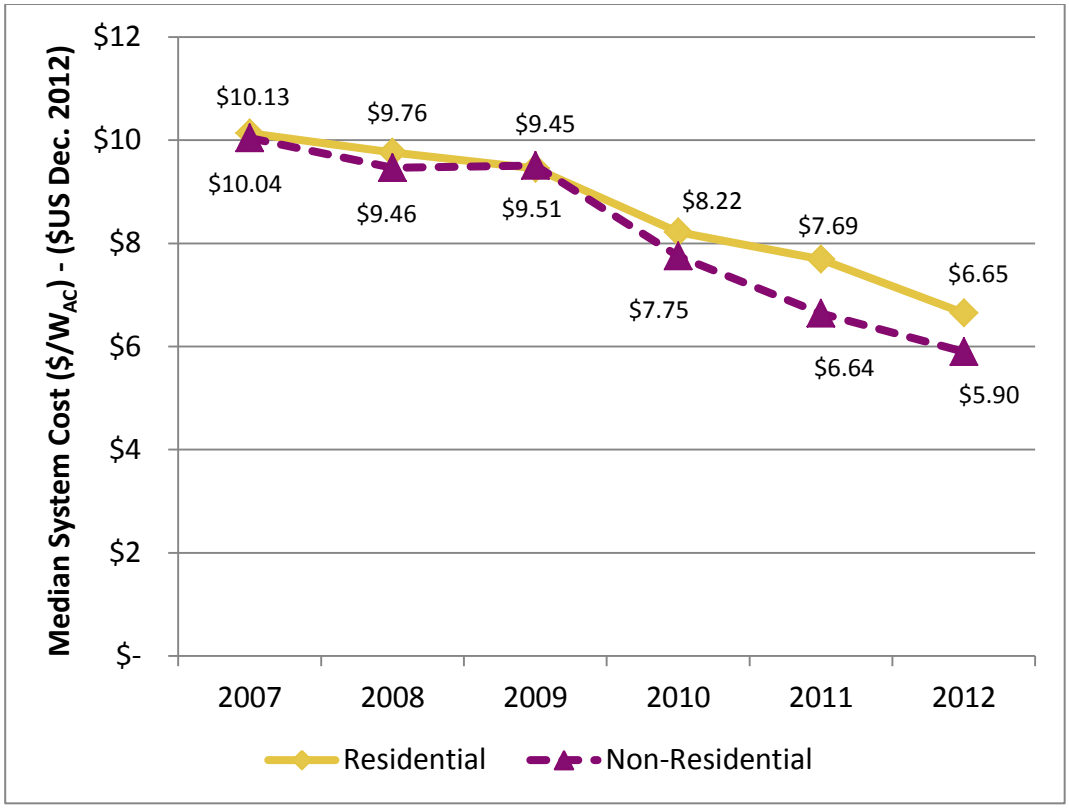
Reductions in median installed system costs may reflect several aspects of a transforming and maturing market. For example, costs may come down because of increased market demand (due to learning effects and economies of scale) and the subsequent increase in competition among suppliers vying for market share. Notably, such learning effects and economies of scale can occur at both the local level (i.e., for a particular California-based installer) and globally (i.e., for a module manufacturer).

[24] California Department of Finance. "Consumer Price Index (CPI) for U.S. and California." Accessed October 2013. http://www.dof.ca.gov/html/fs_data/latestecondata/documents/BBCPIUM.xls.

Key Findings

1. **Median total system costs have declined steadily.** The Navigant team's analysis revealed that median total costs for installed host-owned systems have decreased over the course of the CSI Program for both residential and non-residential PV systems. Figure D-1 shows the summary results from this analysis. These cost declines began slowly over the first three years of the CSI Program, followed by more substantial annual reductions between 2010 and2012.

Figure D-1. Median Reported System Cost ($/W) for Host-Owned Systems by Year Installed



Note: Reported total system cost was inflated to December 2012 $U.S. using the CPI for California.

Source: Navigant team analysis of PowerClerk database extract through December 31, 2012.

2. **Costs are in decline due to increased global production of modules and inverters as well as diminished soft costs.** These decreases in total costs reflect the broader global pricing trends discussed in subsection 2.1.2. According to interviewed market actors, global reductions in module and (to a lesser extent) inverter prices have been the primary drivers of these cost reductions. However, industry players also pointed to decreases in system soft costs (e.g., permitting) that have occurred as demand has increased. To the degree that increasing rates of system and capacity additions in California correspond to these cost reductions (see subsection 2.3.2), they may partly reflect localized learning effects and other efficiencies among system

installers and solar finance companies (SFCs) operating in California. Unfortunately, separating the influence of such local effects from global market trends is a difficult and tenuous task.

Suggestions for Future Tracking

Interviewed market actors broadly acknowledged the reported system cost data in the PowerClerk database as one of the key benefits of the CSI Program. No other data source currently provides a comparable level of coverage and specificity to the California market. (Utility interconnection data does not track system costs.) The increasing popularity of third-party ownership has also meant that a shrinking share of the PV systems installed each year can be included in this analysis (since TPO system costs are considered inconsistently or inaccurately reported). Potential approaches for tracking this information in the future might include the following:

- Requiring some form of cost reporting as a condition for interconnection (If there are compliance costs, they would likely be passed to customers and create an administrative burden for utilities.)
- Offering a reasonable incentive to installers, SFCs, or host customers to voluntarily report cost information
- Conducting periodic surveys of host customers

Data Sources

Navigant team analysis of CSI PowerClerk database, August 2013.

D.1.1.2 Indicator: Volume ($) of Projects Financed Through Standardized Financial Products

Description of MTI

This indicator illustrates the degree to which solar PV project financing has transitioned from a collection of individually negotiated transactions to a market-wide business practice requiring agreements with consistent terms and conditions that can be compared for the purpose of valuation.

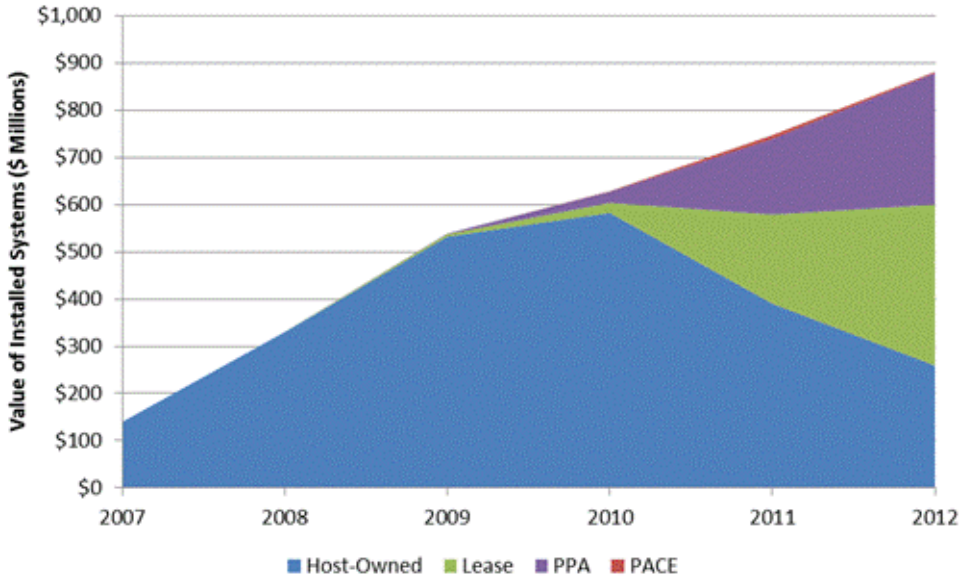
What this Indicator Tells Us About the Market

Standardization reduces transaction costs and increases predictability. Predictability reduces risk and lowers financing premiums, which tends to reduce ongoing ownership costs. If these costs decline, then total cost of ownership will be less and solar PV will become more attractive to residential and non-residential customers.

Key Findings

Capital providers, SFCs, installation contractors, and other market actor interview respondents concurred that the residential market had seen consistent standardization of financial products from 2007 to 2012. When shown the proportion of financing arrangements used in the residential market in Figure D-2, the respondents reported that the relative values and timing were generally accurate.

Figure D-2. Value of Installed Residential Systems by Financing Type, 2007–2012



Source: Navigant team analysis of PowerClerk database extract through December 31, 2012.

In the survey of CSI participants, 58 percent of respondents that financed their host-owned system used a home equity line of credit. Applying this proportion to the analysis of PowerClerk data depicted in Figure D-2, the Navigant team estimates that the remaining host-owned systems (those that did not use a standardized product) equals approximately one-tenth of all installations.

Given the growth of the residential market since 2007and the ascendancy of standardized financial products such as power purchase agreements (PPAs), leases, and home equity loans within that growing market, it appears that the residential market generally has standardized financing.

The non-residential market is another matter. All interview respondents indicated that standardized financial products are not yet in common use in the non-residential market; however, the National Renewable Energy Laboratory recently began publishing model agreements for this market. Some interview respondents recognized the potential value of standardized financial products for non-residential transactions, but were not optimistic that they would achieve widespread adoption in the near future. The primary factor cited was the relatively greater negotiating power of each non-residential customer, many of whom have individual (and sometimes unique) contracting policies that prevent the application of a standardized agreement.

The difference in adoption of standardized financial products between the two markets is evidence of partial transformation. The relative lag in adoption by non-residential customers likely reduces market efficiency and delays cost reductions that might otherwise support additional installations.

Suggestions for Future Tracking
Continue to interview market actors on a regular (annual or bi-annual) basis to determine the level of adoption of standard financial products in both the residential and non-residential markets.

Data Sources

- In-depth interviews of arrangers of capital, solar finance companies, installation contractors, and other market actors
- Telephone survey of CSI participants

D.1.1.3 Indicator: Permit/Approval Waiting Time (Total Idle Time)

Description of MTI
Permit/approval time declines (total idle time). For this indicator, the Navigant team collected estimates from permitting officials and market actors, and reviewed secondary literature to document whether total idle time actually declined over 2007–2012.

What this Indicator Tells Us About the Market
The premise of this indicator is that longer idle time drives up first costs to customers. If total idle time is in decline, this transactional friction will be less and the price of customer-side solar PV will become more attractive to residential and non-residential customers.

Key Findings

Perhaps the least surprising finding of this study is that permitting authorities, installation contractors, and solar finance companies have very different perspectives on idle time when responding to the Navigant team's interviews. Permitting authorities view this concept as the time it takes to process an applicant's paperwork plus the time to comply with any outstanding code requirements. Installation contractors see idle time as the permitting process and the interconnection process. Solar PV finance companies go beyond these viewpoints to include other project development issues (such as CSI application and customer acquisition). With these differing perspectives, estimates of residential system idle time varied from audience to audience, as shown in Table D-1. Respondent estimates for non-residential permits were approximately seven to ten days longer than those listed in the table below.

Table D-1. Residential Installation Idle Time Perspectives from 2013

Respondent Audience	Idle Time Perspective	Minimum Idle Time	Average Idle Time	Maximum Idle Time
Permitting Authority (5)	Permitting + Compliance	1 day	14 days	Depends on Compliance Issues
Installation Contractor (7)	Permitting + Compliance + Interconnection	3 days	21 days	60 days
Solar Finance Company (11)	Permitting + Compliance + Interconnection + Other Product Development	14 days	30 days	100 days

Source: Navigant team analysis of interview responses.

It appears that little change in permitting times has occurred, according to a 2009 study sponsored by the Sierra Club.[25] That study surveyed 250 municipalities in Southern California in an effort to assess what fees and processing times were required for obtaining a permit to install a residential customer-side PV system. Results indicated that most jurisdictions had a period of one to two weeks between submission and issuance of a permit. Forty-one municipalities had a policy of consistently issuing permits over the counter (OTC), resulting in a processing time of a few hours or less. The longest wait time to obtain a permit was two weeks or more (ten business days), which was reported by 34 municipalities. The Sierra Club concluded that a policy of OTC permit issuance is the most efficient method for processing permits.

When asked when their current solar PV permitting processes began, the majority of permitting authority respondents interviewed for this study identified 2008 as the start of OTC issuance and other process streamlining efforts. These respondents identified the increased number of installations and CSI as the drivers for these process improvements and stated that any delays likely stemmed from a lack of permitting process capacity. From the perspective of permitting authorities, idle time appears to have decreased since the start of CSI but has leveled off in recent years.

[25] Carl Mills et al. 2009. *Solar Electric Permit Fees in Southern California, A Comparative Report*. Prepared for Sierra Club.

Installation contractor and solar PV finance company interview respondents were evenly split regarding changes in idle time since 2007. Three of the 7 installation contractor respondents and 3 of the 11 SFC respondents stated that idle time had stayed the same or gotten worse since 2007. While nearly all respondents recognized the value of OTC permitting, they identified inconsistent permitting requirements among jurisdictions as the primary factor preventing an overall decline in idle time. This unpredictability increases risk and expense for the supply chain, which is eventually passed on to the customer.

These mixed responses indicate that this barrier to reducing first and maintenance costs to customers has not been uniformly worn down. As customer-side solar PV expands across the state, it is likely that permitting authorities with limited exposure to customer-side solar PV will traverse a learning curve similar to that of the jurisdictions that saw the first wave of installations in 2007 and 2008. This may limit, or conceivably reverse, the average idle time for the market. For this reason, future evaluations should differentiate idle time in jurisdictions new to this type of permitting and those jurisdictions with experience.

Further, Table D-1 makes clear that the broader the respondent audiences' viewpoint, the more comprehensive the definition of idle time. If the average idle time declines for each type of respondent in future studies, this indicator could be considered widespread. If declines occur for only some of the audiences, the indicator would continue to be considered partial. If none of the audiences indicated a decline, market transformation may be stagnating for this indicator.

Suggestions for Future Tracking

- Bi-annual interviews of market actors, including but not limited to, installation contractors and solar finance companies as well as permitting authorities
- Bi-annual reviews of permitting authority files to develop an estimate of the length of time between application and approval

Data Sources

- Interviews with permitting authorities, installation contractors, and solar finance companies
- Mills, Carl, Kurt Newick, Jim Stewart, and Tamara Winter Compean. 2009. "Solar Electric Permit Fees in Southern California: A Comparative Report."
- Wiser, Ryan and C.G. Dong. 2013. "The Impact of City-Level Permitting Processes on Residential PV Installations."
- "Permitting Processes on Residential Photovoltaic Prices and Development Time: An Empirical Analysis of Solar Systems in California Cities." Lawrence Berkeley National Laboratory – Energy Analysis – Electricity Markets and Policy Group. 2013.

D.1.2 Increase in Customer Confidence in Qualifying Equipment

While cost was the preeminent barrier to adoption of customer-side solar PV, equipment performance uncertainty (among customers) was the penultimate. For CSI to have reduced performance uncertainty,

investor-owned utilities (IOUs) would have to communicate successfully the opportunity and benefits of solar PV systems to their California customers. The indicator of this success is an increase in awareness, as measured by surveys of program participants and non-participants, regarding this option and these benefits.

D.1.2.1 Indicator: Customer Awareness of Solar PV and its Benefits Increases

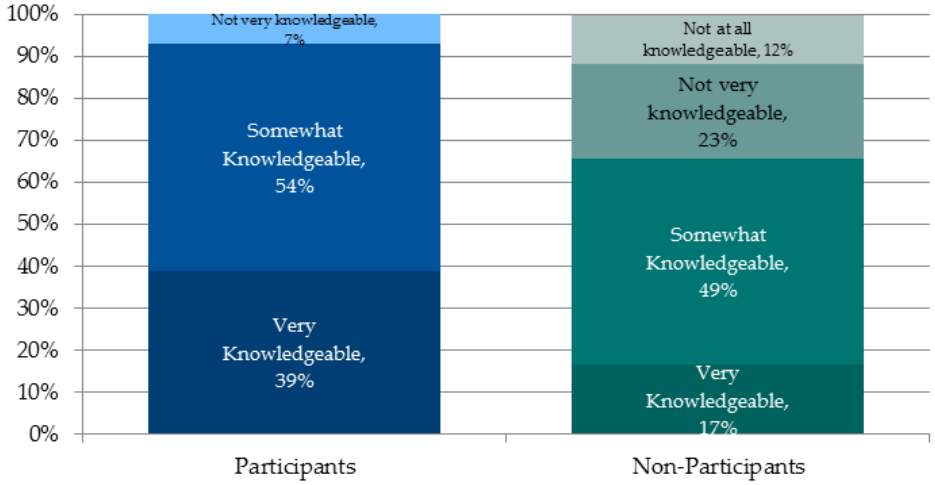
Description of MTI
This indicator can be measured through several individual metrics, including the following:

- Participants' and non-participants' self-assessed knowledge of solar PV
- Percentage of participants and non-participants with friends and family who have adopted solar PV
- Benefits of solar PV considered by participants and benefits perceived by non-participants
- Percentage of participants and non-participants who are aware of financial incentives to aid with cost of solar PV

What this Indicator Tells Us About the Market
Adoption of solar PV is expected to increase as customers become more familiar with customer-side solar PV and its financial and non-financial benefits.

Key Findings
Most residential customers have some knowledge of solar PV energy; 93 percent of participants and 65 percent of non-participants are very or somewhat knowledgeable (Figure D-3). Just 12 percent of non-participants indicate they have *no* knowledge about solar PV energy. Solar PV knowledge is likely being transmitted by word of mouth; 65 percent of participants and 45 percent of non-participants have friends or family who have adopted solar PV.

Figure D-3. Residential Participants' and Non-Participants' Knowledge of Solar PV



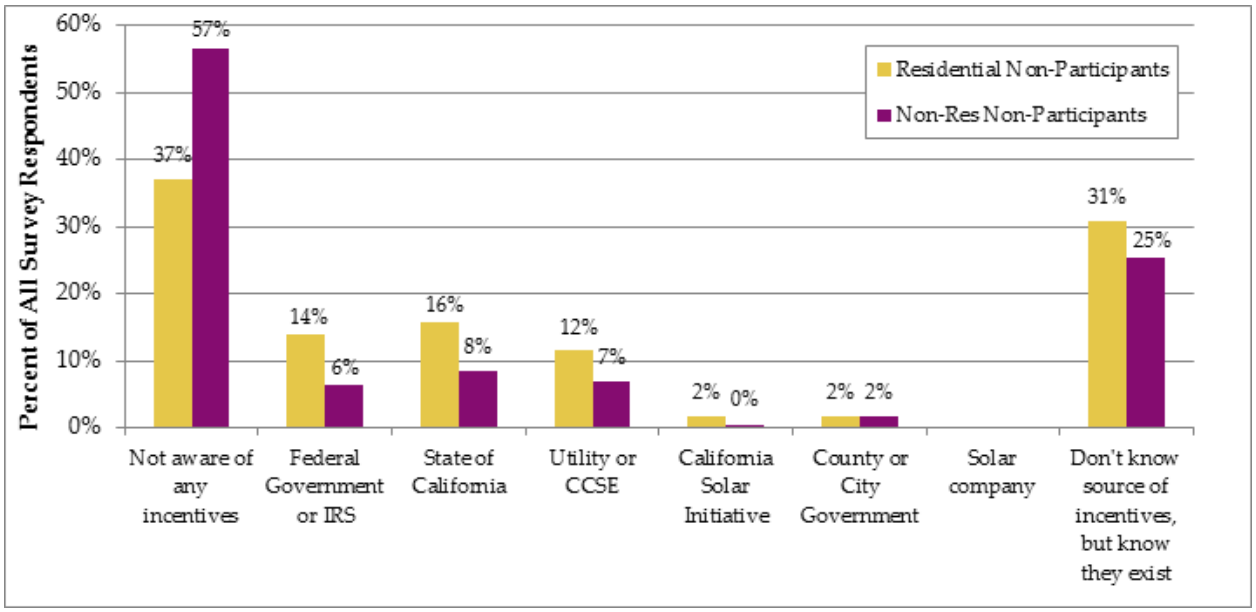
Sources: Navigant surveys of 72 residential CSI participants and 300 non-participating residential customers.

Participants and non-participants view the benefits of solar PV similarly. Residential participants report that "saving money and controlling electric bills" was very motivational in their decision to install solar PV (average rating of 4.5 on a 5-point scale); 77 percent of non-participating residential participants believe that people adopt solar PV to save money and control energy costs. The environmental benefits are also very motivational to participants (average rating of 4.0), and 38 percent of non-participants identified "helping the environment" as a reason for installing solar PV. Just 5 percent of non-participants were unable to name a single benefit of adopting solar PV, indicating that 95 percent of residential non-participants are familiar with at least one benefit of solar PV.

Non-residential participants and non-participants responded very similarly; the top benefits rated by participants are saving money and controlling electric bills (average rating of 4.7) and helping the environment (average rating of 4.2). Non-participating non-residential customers believe that organizations most often adopt solar PV to save money and control costs (76 percent) and to help the environment (23 percent). Ten percent of non-residential non-participants don't know why organizations adopt solar PV, indicating that 90 percent of non-residential non-participants are familiar with at least one benefit of solar PV.

Though many non-participants are familiar with the benefits associated with solar PV and correctly identify "saving money" as a key benefit, relatively few are familiar with the sources of financial incentives to aid with the cost of solar PV (Figure D-4). The majority (63 percent) of residential non-participants are aware that financial incentives exist, though almost half of those aware don't know who provides those incentives. Less than half (43percent) of non-participating non-residential customers are aware of financial incentives. Just 14 percent of non-participating residential customers and 6 percent of non-participating non-residential customers are aware that there are federal tax incentives for solar PV.

Figure D-4. Non-Participants' Awareness of Financial Incentives for Solar PV



Sources: Navigant surveys of 300 non-participating residential customers and 305 non-participating non-residential customers.

Suggestions for Future Tracking
Periodic surveys of non-participating customers will assist in measuring changes in customer awareness over time. A survey exploring non-participants' awareness of incentives and financing options (including leases, PPAs, and perhaps PACE financing) would be especially beneficial.

Data Sources
Surveys of participants and non-participants in the residential and non-residential sectors, 2013

D.1.3 Expanded and Enhanced Supply Chain

This outcome focuses on the supply side of the market while the previous indicator focused on the demand side. If CSI merely boosted demand but did not develop a working supply chain, market transformation would be limited at best. The expanded and enhanced supply chain refers not just to the number but the financial strength of the market actors. Over time, smaller installers will focus on their local markets while larger, better-financed organizations will expand into new geographies. In order to survive, smaller firms will ally themselves with larger organizations or become very effective in serving their immediate communities.

While CSI had activities that directly affected installation contractors, the most profound effect of the initiative was reduced risk for market actors that arranged and provided capital and developed innovative financing mechanisms. CSI accomplished this by defining the market for customer-side solar PV with a predictably decreasing incentive and market information that reduced uncertainty in this market. To assess whether these effects actually transformed the market, the Navigant team focused on the following two indicators:

- Increasing capital availability to support installers
- Increasing number of annual inventory turns

D.1.3.1 Indicator: Increasing Capital Availability to Support Installers

Description of MTI
This indicator sheds light on the lifeblood of the solar PV supply chain: capital – with specific attention to the working capital required for operations or expansion. Interviews with solar PV finance companies and installation contractors were the primary information sources for analysis of this indicator.

What this Indicator Tells Us About the Market
If installation contractors do not have sufficient working capital, it will not be possible to expand or enhance the supply chain to meet growing demand. In this context, the availability of working capital defines the rate of growth.

Key Findings
Nearly all interview respondents reported that access to working capital is a limiting factor for installation contractors in terms of expansion but not ongoing operations. When asked if this limiting factor constitutes a barrier, respondents stated that it limited expansion but was not a barrier to existing operations. Several respondents went on to state that larger installation contractors with greater creditworthiness tended to have greater access to capital; these larger firms would likely see this access

increase over time as solar PV installations become more common. On the other hand, respondents indicated that smaller contractors tended to have more limited access to capital for expansion beyond their local market.

Interview respondents suggested that the lack of access to working capital was a function of a limited supply of willing lenders rather than a prohibitively high cost of borrowing. Because conventional lending institutions still see customer-side solar PV as a new or novel commercial endeavor, installation contractors are considered less investment-worthy than other businesses of similar size and operation. Lenders' perception of solar PV installation as an unproven business model leads to a perception of increased risk. Instead of translating increased risk to higher premiums on loans, lenders simply limit their exposure to this type of firm, especially smaller, locally focused enterprises.

The immediate effect of lenders limiting capital for this market is that smaller installation contractors may be thwarted in their efforts to expand into other regions of the state or from the residential to non-residential sectors (or the reverse). The long-term effect may be the consolidation of smaller installation contractors in favor of larger, better-financed firms. The loss of smaller installation contractors may indicate market maturation and overall increased efficiency.

While the respondents generally reported that installation contractor access to capital was the governing factor in the rate of supply-chain growth, none of the respondents indicated that customer demand went unmet due to lack of access to capital. As the market for customer-side solar PV continues to grow, the better-financed installation contractors (usually the largest) will have a competitive advantage that will lead to greater efficiency of delivery. Over time, this advantage will tend to drive a population of better-financed market actors within the supply chain that serves California. This trend is an aspect of market maturation in which the supply chain begins to concentrate and specialize. In this context, this indicator of market transformation appears to be present.

Based on the responses from arrangers of capital and SFCs, market actors expect working capital to increase in availability to the more established firms. Future studies should confirm this trend with interviews of market actors in the supply chain and lenders. If market transformation continues into the future, these interviews should reveal new lenders and new financial products.

Suggestions for Future Tracking
Interviews with market actors as well as lenders

Data Sources
Interviews with market actors

D.1.3.2 Indicator: Increasing Annual Inventory Turns for Equipment to Serve Installers

Description of MTI
Annual inventory turns represent the number of times in a year that a firm (in this case a distributor or installation contractor) receives equipment into stock and then sells it (i.e., turns it over). For the purposes of this study, the Navigant team estimated that distributors would have an inventory turn of

six (i.e., an average holding time of two months) for both modules and inverters. The Navigant team then asked market actors if this estimate was too high or too low.

This is the first time a study of this market has made this inquiry, so these findings will be the baseline against which future measurements will be made.

What this Indicator Tells Us About the Market
The speed at which goods move from manufacturer to market is a key metric of supply-chain health. Changes in the number of inventory turns for modules and inverters indicate if such movement is accelerating or stagnating. If market actors report increasing inventory turns, then the supply chain is likely expanding to meet demand. If not, then demand may have plateaued or begun to decline.

Key Findings
Installation contractor interview respondents indicated that six annual inventory turns was a reasonable expectation for firms serving the California residential market. One respondent indicated that they had a target of 30 annual turns but this firm was an outlier. In general, installers serving the non-residential market indicated that the number of turns might be slightly lower, depending on the scale of individual projects in a given year.

As context for this indicator, if manufacturers were unable to supply installation contractors, then this indicator would have limited information value. However, none of the respondents indicated that they experienced consistent procurement difficulties from 2007 to 2012. To avoid confounding observations in future research, data collection efforts should consider such supply trends.

Because this study is the first effort to examine inventory turns as an indicator of market transformation, it is not possible to determine if inventory turns increased or decreased from 2007 to 2012. However, future research should compare market actor estimates of inventory turns to the six-turn benchmark.

Suggestions for Future Tracking
Regular (annual or bi-annual) interviews with market actors

Data Sources
Interviews with arrangers of capital, solar finance companies, installation contractors, and other market actors

D.2 Indicators of Progress Toward Long-Term Outcome: Increase in Overall Market Size

If the program achieved the intermediate-term outcomes presented in subsection 4.3 of the main report, CSI Program logic posited that continued CSI activities would lead to the long-term outcome: an increase in overall market size. The Navigant team explored the following three indicators of this potential long-term outcome:

- Increasing geographic scope of installations
- Increasing number of installations per capita

- Increasing diversity in customer demographics

D.2.1.1 Indicator: Increasing Geographic Scope of Installations

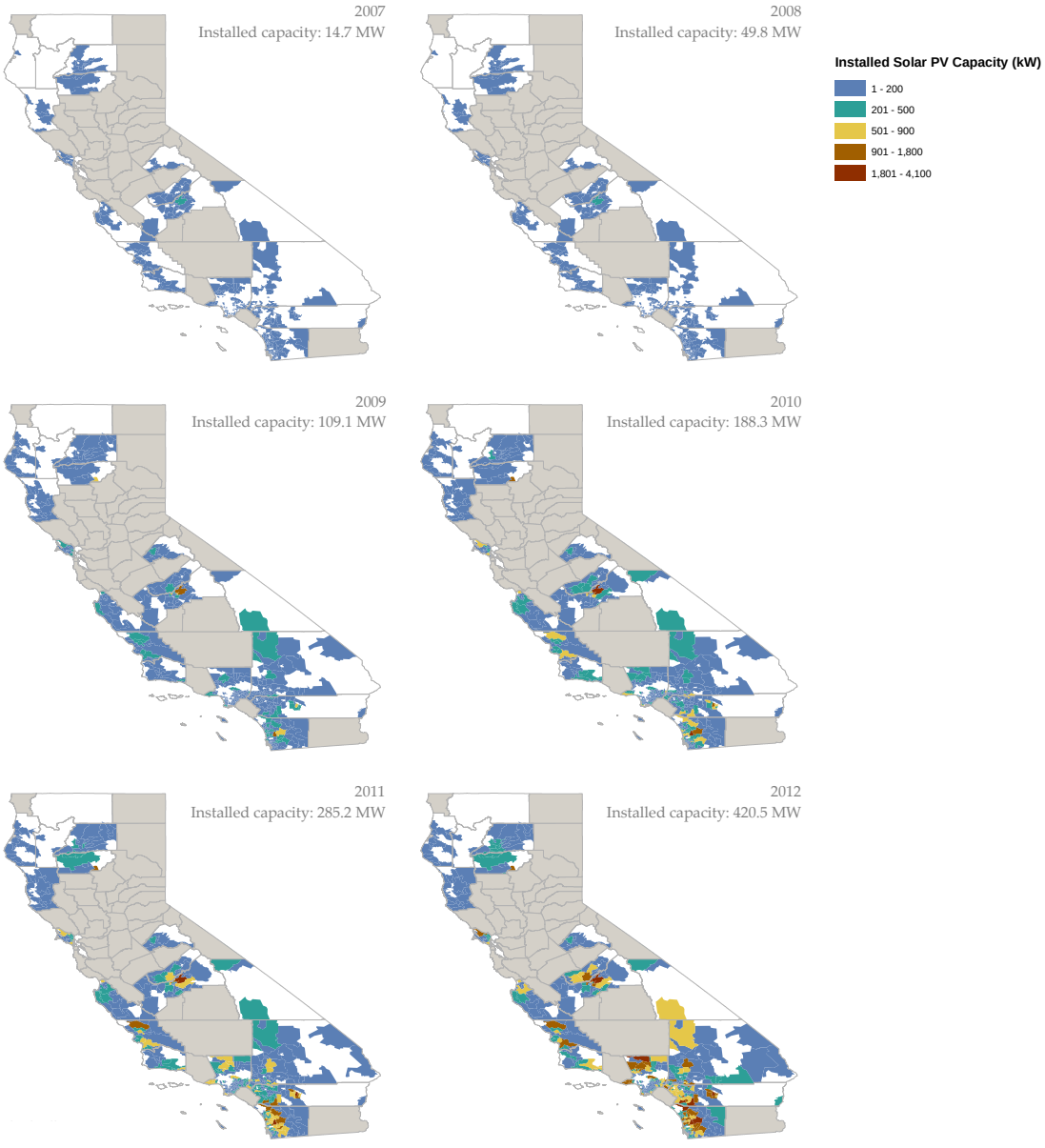
Description of MTI
Navigant used the CSI PowerClerk database to analyze the geographic scope of installations. The Navigant team used the installed capacity (kilowatt [kW]) data and the ZIP code of the host customer physical address. The analysis disaggregated residential and non-residential systems, and the Navigant team examined trends at annual increments.

What this Indicator Tells Us About the Market
This indicator shows the geographic distribution of the installed solar PV capacity. Viewing the geographic data over time can provide insights into the growth of solar PV capacity in the state. Increasing the locations of solar PV installations over time would indicate that the market for solar PV is coming from diverse regions of the state and is extending out from early adoption regions.

Key Findings

1. **The installed solar PV capacity has increased in terms of geographic scope throughout the state.** The percentage of total California ZIP codes with installed solar PV capacity increased from 43 percent in 2007 to 75 percent in 2012 in the residential sector. The percentage of total California ZIP codes with installed solar PV capacity increased from 6 percent in 2007 to 55 percent in 2012 in the non-residential sector. Figure D-5 and Figure D-6 contain maps showing the cumulative installed capacity by year. Each figure contains six maps, one for each year from 2007 through 2012. The data is mapped by ZIP code area, and the colored shading of each ZIP code area indicates the cumulative installed solar PV capacity (in kW) in the ZIP code area. Figure D-5 contains maps for the residential sector, while Figure D-6 contains maps for the non-residential sector. Over time, the maps show the installed capacity has increased in ZIP code areas through a change in color from cool blue (low installed capacity) to warm red (high installed capacity), and show that ZIP code areas that did not have any installed capacity in previous years installed solar (ZIP code change from white to a colored shading).

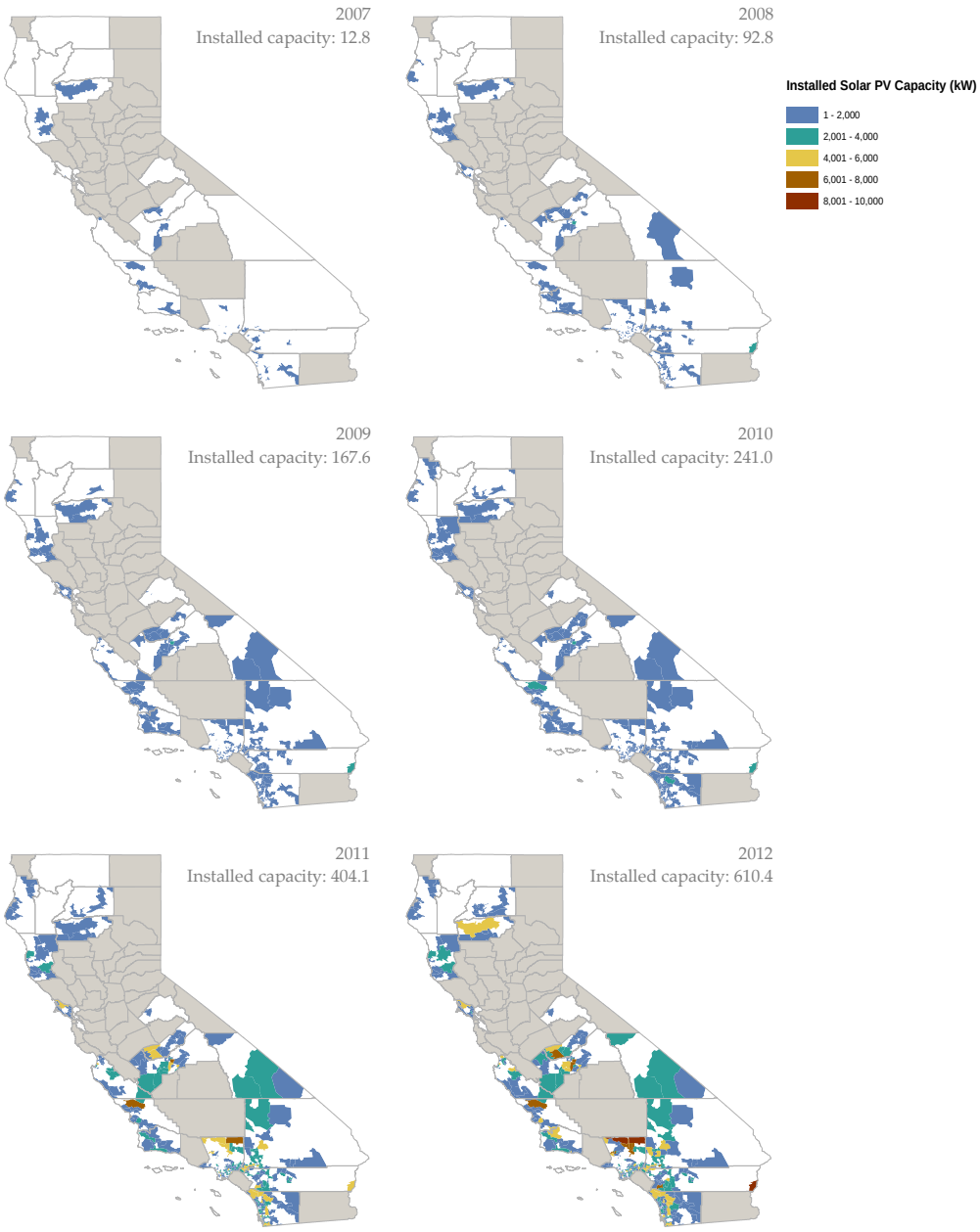
Figure D-5. California Solar Initiative Cumulative Installed Capacity (Residential)



Note: About 1 percent of the overall capacity is not shown on the map due to ZIP codes not available on the map and data not matched to a ZIP code.

Source: Navigant team analysis of PowerClerk database extract through December 31, 2012.

Figure D-6. California Solar Initiative Cumulative Installed Capacity (Non-Residential)

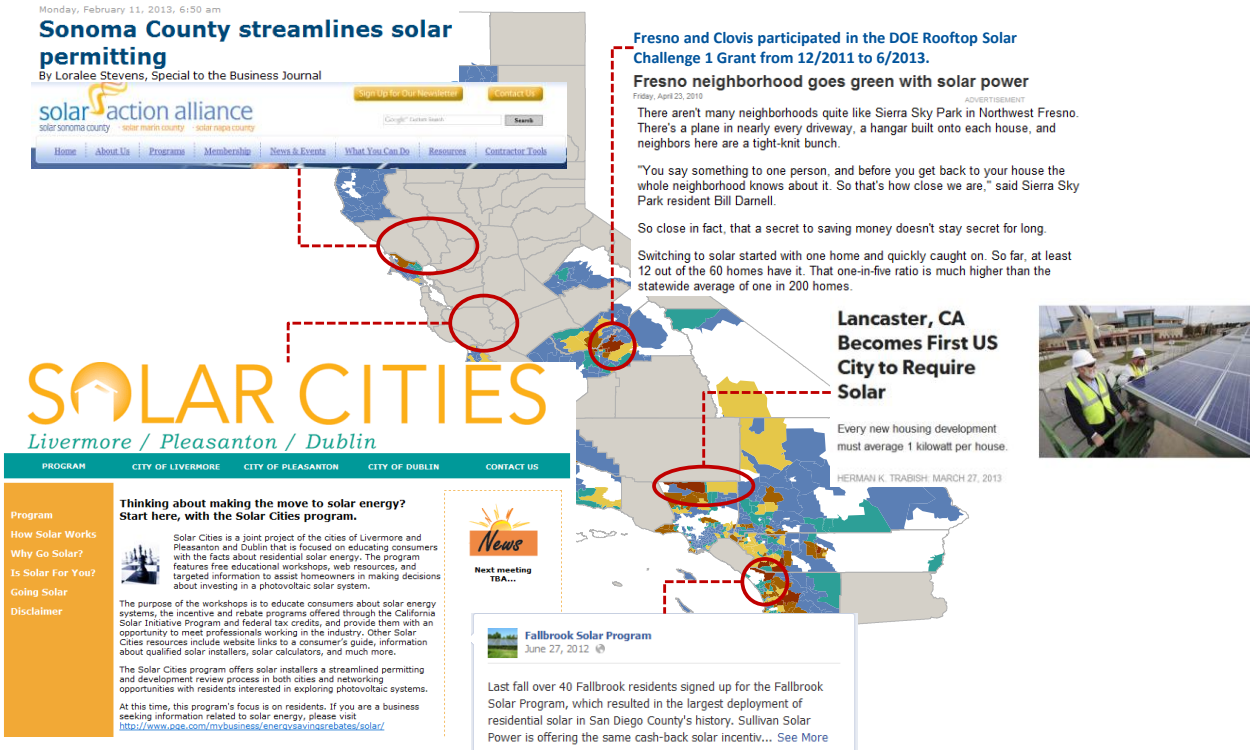


Note: About 2 percent of the overall capacity is not shown on the map due to ZIP codes not available on the map and data not matched to a ZIP code.

Source: Navigant team analysis of PowerClerk database extract through December 31, 2012.

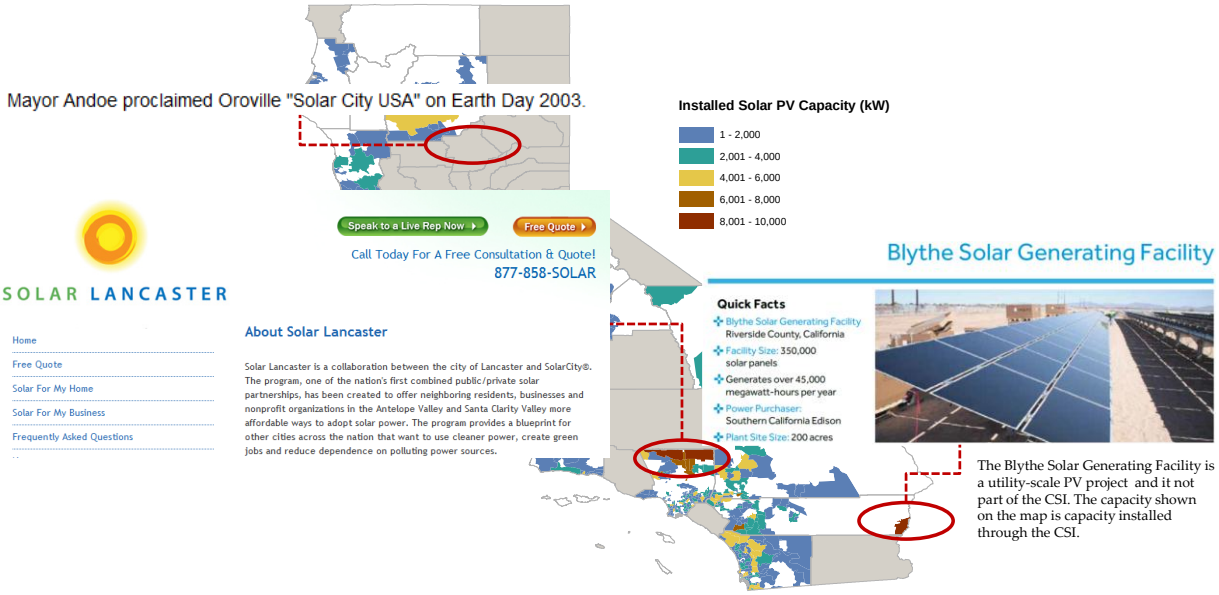
2. **Regions have developed into hot spots.** Multiple regions in California have developed over time into hot spots, areas with relatively high installed solar PV capacity. Figure D-7 identifies some of the hot-spot areas in the residential sector and Figure D-8 identifies some of the hot-spot areas in the non-residential sector. The hot-spot areas are shown on the map of the cumulative installed capacity in 2012. Hot-spot areas include Lancaster, CA, which became the first U.S. city to require solar PV on new housing developments, and the Sonoma/Napa/Marin area, which has developed a solar PV action alliance and has worked to streamline solar PV permitting.

Figure D-7. Areas with High Installed Solar PV Capacity (Residential)



Sources: Source: Navigant team analysis of PowerClerk database extract through December 31, 2012. "Sonoma County streamlines solar permitting," North Bay Business Journal, accessed November 21, 2013, http://www.northbaybusinessjournal.com/68565/sonoma-county-streamlines-solar-permitting/; "Solar Action Alliance," accessed November 21, 2013, http://solaractionalliance.org/; "Fresno neighborhood goes green with solar power," ABC, accessed November 21, 2013, http://abclocal.go.com/kfsn/story?section=news/consumer&id=7402109; "Lancaster, CA Becomes First US City to Require Solar," Greentech Media, accessed November 21, 2013, http://www.greentechmedia.com/articles/read/Lancaster-CA-Becomes-First-US-City-to-Require-Solar; "Solar Cities," accessed November 21, 2013, http://solarcitiesnow.com/; "Fallbrook Solar Program," http://www.sullivansolarpower.com/fallbrook-solar-program; "SunShot Rooftop Challenge Awardees," U.S. Department of Energy, accessed November 21, 2013, energy.gov/articles/sunshot-rooftop-challenge-awardees.

Figure D-8. Areas with High Installed Solar PV Capacity (Non-Residential)



Source: Source: Navigant team analysis of PowerClerk database extract from 2007 through December 31, 2012. "Solar Lancaster," accessed November 21, 2013, http://solarlancaster.org/about.aspx; "Blythe Solar Generating Facility," NRG Solar, accessed November 21, 2013, http://www.nrgsolar.com/docs/factsheet_blythe.pdf; "196 kW Solar Energy Boost on Earth Day," Renewable Energy World.com, accessed November 21, 2013, http://www.renewableenergyworld.com/rea/news/article/2004/04/196-kw-solar-energy-boost-on-earth-day-11000.

Suggestions for Future Tracking

In order to continue tracking the geographic scope of installations, it is important to continue recording the installed solar PV capacity by location, in this case ZIP code, in a central database location.

Data Sources:

- Navigant team analysis of CSI PowerClerk database
- "Sonoma County streamlines solar permitting," North Bay Business Journal, accessed November 21, 2013, http://www.northbaybusinessjournal.com/68565/sonoma-county-streamlines-solar-permitting/
- "Solar Action Alliance," accessed November 21, 2013, http://solaractionalliance.org/
- "Fresno neighborhood goes green with solar power," ABC, accessed November 21, 2013, http://abclocal.go.com/kfsn/story?section=news/consumer&id=7402109
- "Lancaster, CA Becomes First US City to Require Solar," Greentech Media, accessed November 21, 2013, http://www.greentechmedia.com/articles/read/Lancaster-CA-Becomes-First-US-City-to-Require-Solar
- "Solar Cities," accessed November 21, 2013, http://solarcitiesnow.com/
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- "SunShot Rooftop Challenge Awardees," U.S. Department of Energy, accessed November 21, 2013, energy.gov/articles/sunshot-rooftop-challenge-awardees
- "Solar Lancaster," accessed November 21, 2013, http://solarlancaster.org/about.aspx
- "Blythe Solar Generating Facility," NRG Solar, accessed November 21, 2013, http://www.nrgsolar.com/docs/factsheet_blythe.pdf
- "196 kW Solar Energy Boost on Earth Day," Renewable Energy World.com, accessed November 21, 2013, http://www.renewableenergyworld.com/rea/news/article/2004/04/196-kw-solar-energy-boost-on-earth-day-11000

D.2.1.2 Indicator: Increasing Number of Installations per Capita

Description of MTI

Navigant used the CSI PowerClerk database to analyze the number of installations per capita. The Navigant team used the installed capacity (kW) data and the ZIP code of the host customer physical address. The analysis aggregated residential and non-residential systems. The Navigant team also used the population data from the U.S. Census Bureau. In addition, the Navigant team viewed the number of residential installations per 1,000 single-family detached housing units at the county level and used the U.S. Census American Community Survey data for this analysis.

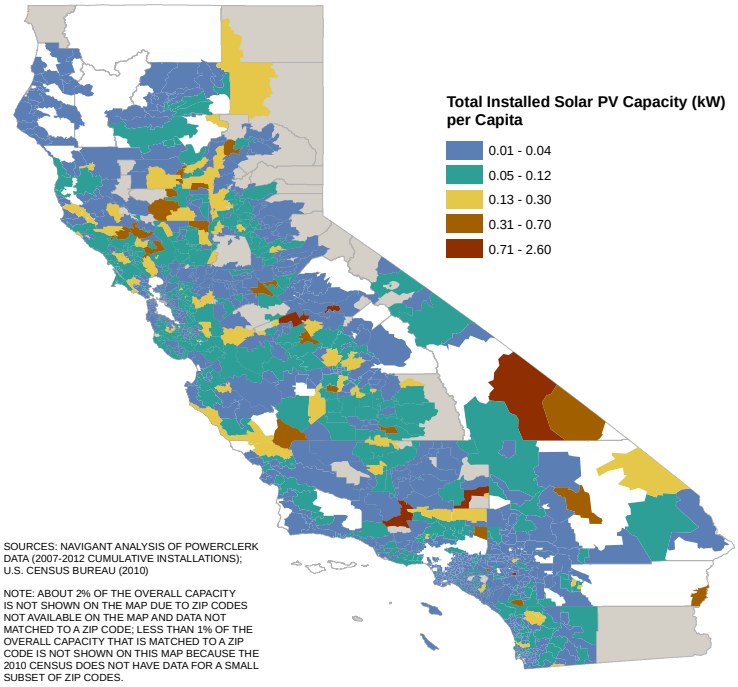
What this Indicator Tells Us About the Market

This indicator shows the areas of high and low solar PV capacity per capita and solar PV installations per housing unit. Areas of high solar PV capacity per capita or high solar PV installations per housing unit have high solar PV adoption rates, while areas of low solar PV capacity per capita or low solar PV installations per housing unit have lower solar PV adoption rates.

Key Findings

1. **Installed solar PV capacity per capita varies across the state.** The total installed solar PV capacity per capita ranged from 0.00025 kW/capita to 2.6 kW/capita by ZIP code area. Figure D-9 shows the installed capacity per capital for all ZIP codes in California. The map shows areas with low capacity per capita in blue and areas with high capacity per capita in red.

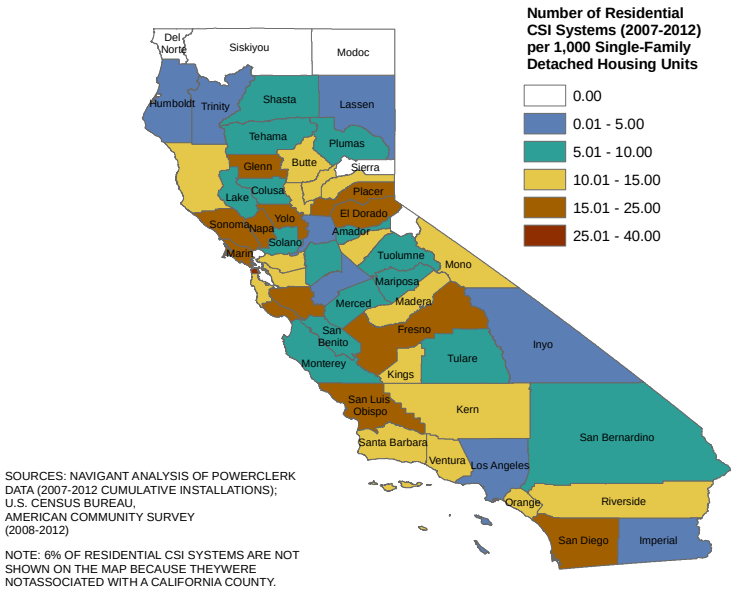
Figure D-9. California Solar PV Initiative Cumulative Installed Capacity per Capita (Residential and Non-Residential Capacity)



Sources: Navigant team analysis of PowerClerk database extract through December 31, 2012; U.S. Census Bureau. 2010.

2. **The number of residential systems per housing unit varies across the state.** At the state level, California residents have installed 11 solar PV systems per 1,000 single-family detached housing units. Figure D-10 shows that the density of residential solar PV systems varies at the county level. The county with the highest density is San Francisco, with 36 residential solar PV systems installed per 1,000 single-family detached housing units.

Figure D-10. Density of Residential CSI Systems by County



Sources: Navigant team analysis of PowerClerk database extract through December 31, 2012; U.S. Census Bureau American Community Survey (2008-2012).

Suggestions for Future Tracking

In order to continue tracking the installations per capita or per housing unit, it is important to continue recording the installed solar PV capacity by location, in this case ZIP code and county, in a central database location. In addition, population data and housing data from the U.S. Census Bureau are available publicly.

Data Sources

Navigant team analysis of CSI PowerClerk database, U.S. Census Bureau (2010); U.S. Census Bureau American Community Survey (2008-2012)

D.2.1.3 Indicator: Increasing Diversity in Customer Demographics

Description of MTI

Customer diversity has not been a metric of past evaluations; therefore, the Navigant team's telephone survey of participants and non-participants will serve as the baseline for future evaluation. However, the Navigant team did collect in-depth interview responses from installation contractors and solar PV finance companies regarding their efforts to diversify the target audiences of their marketing efforts.

What this Indicator Tells Us About the Market
If the market for customer-side solar PV is limited to a small set of demographic segments, it is unlikely that the overall market size will increase for very long. The diversification of customer demographics shows that the market has become deep, not just wide.

Key Findings
Subsection 2.4 describes the demographics of CSI residential participant respondents: older, better educated, and wealthier. The demographics of these respondents appear to have remained about the same from 2007 to 2012. Interview respondents indicate that this may be because solar PV finance companies and installation contractors tended not to change the target of their marketing efforts during this time period – with the exception of offering solar PV to customers with lower credit scores.

By marketing to less creditworthy customers, market actors did expand the overall adoption of customer-side solar PV in California. This expansion is only a limited form of diversification, however, and may lead to default risk in the long term.

These responses indicate that this indicator is generally not present. While California may have a large population of older, well-educated, and wealthy individuals, this market segment will eventually saturate. If other market segments (e.g. younger, less wealthy) do not adopt, the expansion of market size will not occur and market transformation will not progress.

Suggestions for Future Tracking

- Bi-annual surveys of residential and non-residential customers that install solar PV with a sample frame based on interconnection data
- Interviews with market actors

Data Sources

- Telephone survey of CSI participants
- Interviews with market actors

D.3 Evidence of Sustainability

Evidence of sustainability is observable substantiation that the program interventions—in this case, incentives and other CSI-sponsored activities—can be terminated without resulting in a measurable and maintained decrease in the availability of and demand for customer-side solar PV generation. In keeping with the structure of the previous section, this section describes the evidence of sustainability in terms of indicators. Unlike the previous section's MTIs that focused on the past effects of CSI, the presence of the indicators in this section explain the likelihood that CSI's effects will continue into the future, past the sunset of the program.

The evidence of sustainability is considered from two perspectives: the demand side of the market and the supply side of the market. Both sides of the market must realize progress in order for the market as a

whole to sustain the changes achieved by CSI after the sunset of the program. The specific evidence of sustainability examined in this section includes two elements:

- Customer demand not reliant on program offerings
- Supply chain expands to meet customer demand

D.3.1 Customer Demand Not Reliant on Program Offerings

The sustainability of CSI's market transformation depends upon future customers' willingness to purchase and the supply chain's willingness to provide solar PV systems. If changes to market structure and market actor behavior are not sufficient to support such willingness, the expansion of adoption will slow, abate, and then diminish. In order to determine the likelihood that transformation will continue, the Navigant team examined the following two indicators:

- Increasing number of installations that do not employ CSI incentives
- Title 24 (T24) updates facilitate or require installation of solar PV

D.3.1.1 Indicator: Increasing Number of Installations that Do Not Employ CSI Incentives

Description of MTI

The Navigant team used each of the three IOU interconnection databases to analyze the share of eligible PV systems interconnected each year that did not receive a CSI General Market incentive or other state-sponsored incentive (e.g., Emerging Renewables Program or Self-Generation Incentive Program [SGIP]).[26] The Navigant team segmented its analysis by sector (residential and non-residential) and examined trends based on both capacity and the number of systems installed. Each of the IOU interconnection databases includes some indication of CSI participation (e.g., "funding source" or "incentive program") that allowed a relatively straightforward calculation of the share of systems not receiving a CSI incentive. Based on IOU evaluation staff suggestions that interconnection applications might not have consistently captured incentive program data during CSI's earlier years, the analysis omitted systems installed in 2007.[27] The Navigant team supplemented its analysis of interconnection data by asking installers and solar PV finance companies about the perceived degree to which companies (their own and others) were bypassing the CSI incentives.

What this Indicator Tells Us About the Market

An increase in the share of PV systems that did not receive a CSI incentive may indicate an increase in the number of systems that are not contingent on the program subsidy. Alternately, as incentive levels have decreased over time, the incremental value provided by the incentive may simply no longer be

[26] The analysis excluded interconnected systems that received a CSI Single-Family Affordable Solar Home or Multifamily Affordable Solar Housing incentive and those that participated in the New Solar Homes Partnership, effectively focusing on those interconnected systems that were "eligible" for the CSI General Market Program. The Navigant team also counted CSI-eligible systems that received funding from other state-sponsored programs (e.g., SGIP), among those systems that received incentives.

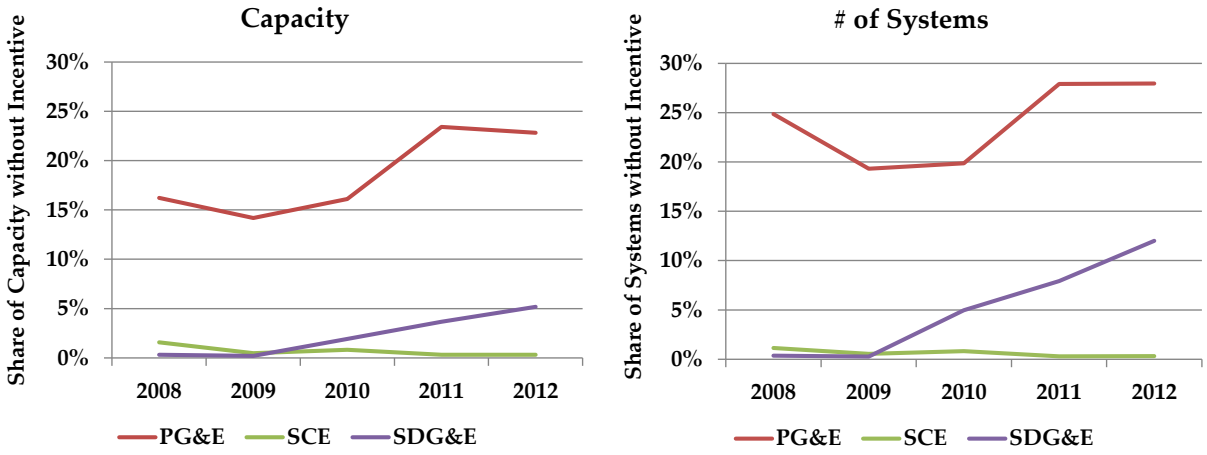
[27] See Appendix A for additional details on the Navigant team's approach to analyzing the interconnection data, including a parallel analysis that attempted to compare capacity and system numbers from the interconnection data with CSI PowerClerk data.

worth the administrative time and expense for installers and solar PV finance companies to pursue. However, if overall demand and installation rates hold steady or continue to increase despite the decline and exhaustion of CSI incentives, it provides sound evidence that the market will be sustainable without that support.

Key Findings

1. **Residential PV systems are increasingly being installed without incentives.** The analysis revealed that the share of capacity and the number of systems not receiving a state incentive in the residential sector increased significantly between 2009 and 2012 in both Pacific Gas and Electric Company (PG&E) and San Diego Gas & Electric Company (SDG&E) territories. However, most residential systems interconnected in Southern California Edison (SCE) territory (>95 percent) continued to receive CSI incentives over that time span. Figure D-1111 and Figure D-12 illustrate the share of residential PV capacity and PV systems, respectively, that did not receive a state-sponsored incentive each year in each utility territory.

Figure D-11. Residential PV Capacity and Number of Systems Interconnected Without State Incentives

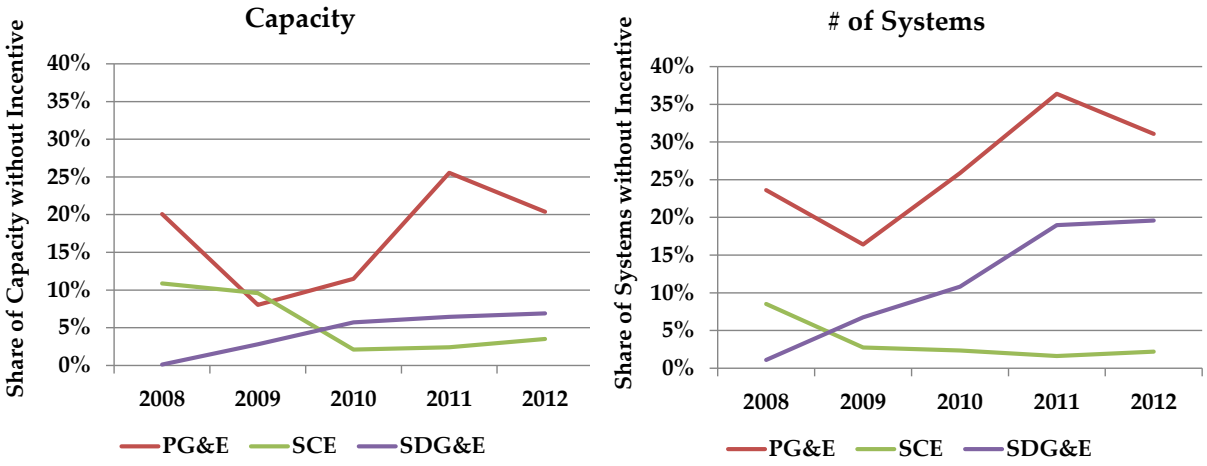


Source: Navigant team analysis of PG&E, SCE, and SDG&E Interconnection Data, October 2013.

2. **Larger systems are more likely to continue applying for CSI incentives.** Comparing the results between non-incentivized capacity and non-incentivized systems in Figure D-1111 reveals that a greater share of total installed systems are bypassing CSI incentives compared to the total installed capacity. This finding suggests that market actors are more likely to bypass the CSI incentive for smaller capacity systems for which the incentive amount may not justify the staff time required to apply. The notion that applying for a CSI incentive has largely become a marginal cost-benefit calculation further supports the hypothesis that at least some market demand no longer depends on the program's support.
3. **These trends also hold true for non-residential PV systems.** The same analysis revealed a similar trend for non-residential systems in each of the three investor-owned utility (IOU)

territories. Figure D-1212 illustrates the share of non-residential PV capacity and PV systems, respectively, that did not receive a state-sponsored incentive each year in each utility territory.

Figure D-12. Non-Residential PV Capacity Interconnected Without State Incentives



Source: Navigant team analysis of PG&E, SCE, and SDG&E Interconnection Data, October 2013.

A comparison of the residential and non-residential sectors in each IOU territory shows a roughly similar share of capacity bypassing the incentives. However, the discrepancy between capacity and number of systems is more pronounced in the non-residential sector, with a greater share of total systems bypassing CSI incentives than in the residential sector. This difference may arise from the fact that non-residential systems are more likely to use CSI's performance-based incentive (PBI), which automatically applies to systems greater than 30 kW in size. (Smaller systems can choose between PBI or an upfront payment.) The longer-term duration of PBI cash flows (which spread across five years) and the corresponding per-kWh incentive level may further lessen the perceived value of program participation for system owners (including third-party owners).

4. **Market actors confirmed that they are bypassing incentives for an increasing number of systems.** In their interview responses, six installer or solar PV finance company contacts acknowledged that their firms was increasingly selling and installing PV systems without CSI incentives, particularly for residential projects. Three such companies said they had not yet transitioned to projects without incentives, but anticipated they would in the near future. To paraphrase one respondent's take on the transition away from incentives: the certainty and visibility of the timing of the CSI incentive decreases helped drive a corresponding focus on the efficiencies and cost reductions needed to get to an incentive-free model.

Suggestions for Future Tracking

Given the forthcoming exhaustion of CSI incentive funds, it may soon become impossible and unnecessary to track this indicator (unless the program were extended or another incentive took its place). That said, the utilities' interconnection applications and databases provide a reasonable and cost-

effective source for this information. It may be worthwhile to evaluate and, if possible, improve those applications and processes to enhance the accuracy of this metric.

Data Sources
Navigant team analysis of PG&E, SCE, and SDG&E Interconnection Data, October 2013

D.3.1.2 Indicator: T24 Updates Address Solar PV

Description of MTI and Key Findings
The inclusion of a practice in a building code makes it a standard practice; it becomes sustainable in the absence of program incentives. The state of California took a major step toward standardizing the practice of making buildings ready for solar PV installations with the adoption of the 2013 update to Title 24.[28] These changes remove barriers to future installation of solar PV on applicable buildings by reducing the upfront investment required to prepare a building for the installation of a solar PV system. Further room for progress toward this indicator exists as local building codes could affect existing construction and/or require solar PV on applicable buildings.

The 2013 update to Title 24 includes several provisions that facilitate installation of solar PV; these are new since the previous update (2008). The 2013 update includes solar PV-ready requirements for residential and non-residential buildings:

- **Single-family residential buildings** must provide a solar PV-ready roof area of 250 square feet of solar PV zone that meets shading and orientation requirements. Construction plans must mark and show pathways for solar PV. Builders must ensure there is sufficient busbar rating and space on the main service panel for potential solar PV retrofits in the future.
- **Multifamily and nonresidential buildings** must provide a solar PV-ready area of 15 percent of the roof area on the roof or at an adjacent site area. Like residential, this area must meet shading and orientation requirements.

In addition, the fire code and electrical codes provide additional requirements to facilitate future installation of solar PV. The fire code (Part 9) requires panel placement on roofs to be three feet away from valleys, ridges, and hip features. The electrical code (Part 3) provides for connection requirements between system components and for interconnection.

The Title 24 update will primarily affect new construction, a part of the market that CSI did not target. CSI's broad effects in the state, however, contributed to the solar-friendly political climate that drove the adoption of the Title 24 update. Further, these new buildings become part of the existing building stock soon after construction is completed; they would be eligible for CSI incentives (if available). The result is a new market of solar PV-ready buildings that will incur lower site preparation costs than the average existing building stock, making them an attractive target for solar PV installers and solar PV finance companies.

[28] Title 24 is the code of regulations that governs the design and construction of buildings, both new construction and retrofits, in California.

Further opportunity for advancement toward this MTI remains in two areas: (1) adding requirements to install solar PV in Title 24 and (2) creating requirements for existing building stock. First, future updates to Title 24 could include requirements to install solar PV, which would fully standardize the practice of adopting solar PV.[29] Second, the opportunity in the existing building stock is substantial, as more than 90 percent of existing floor area in California is in existing buildings in any given year.[30] Local governments, however, must typically implement regulations to influence solar PV-ready retrofits or installations in existing building stock; this fragmented approach to adopting regulations may cause inefficiencies in the market.

D.3.2 Supply Chain Expands to Meet Customer Demand

Sustainability requires both increasing demand for (unincented) customer-side solar PV and the continued growth of the supply chain. Without a growing and innovating supply chain, demand would go unmet, and the overall market would stagnate. To understand this aspect of continued market growth, the Navigant team examined the following two indicators:

- Increase in the geographic coverage of installers
- Volume ($) of financing for un-incented installation increases

D.3.2.1 Indicator: Increase in the Geographic Coverage of Installers

Description of MTI

The Navigant team assessed this indicator in two ways: first, through interview questions asking about the establishment or acquisition of new offices across California from 2007–2012, and second, through an analysis of PowerClerk data. Since previous studies have not documented this indicator, future estimates of increase (or decrease) will be based on the latter.

What this Indicator Tells Us About the Market

If demand for customer-side solar PV increases across the state, and the supply chain expands to meet this demand, evidence of sustained market transformation would require a commensurate increase in the geographic coverage of installation contractors.

[29] Note that the Warren-Alquist Act does not currently allow the California Energy Commission (CEC) to require solar PV as part of Title 24; this would need to be addressed in order to enable such a requirement.

[30] California Energy Commission. 2013. *Integrated Energy Policy Report – Draft.* Report #CEC-100-2013-001-LCD.

Key Findings

The Navigant team analyzed PowerClerk data for the top 20 installers in CSI and plotted the headquarters and branch locations that serve California customers in Figure D-1313.

Figure D-13. 2013 Headquarters and Branch Offices of Top 20 Installation Contractors

Source: Navigant team analysis of PowerClerk database extract through December 31, 2012.

As of 2013, these installation contractor locations tend to cluster in three areas: San Francisco Bay, the southern California coastal region, and the Central Valley. The first two areas constitute high-density

populations with significant municipal support for customer-side solar PV. The Central Valley, while less densely populated, contains many non-residential customers associated with agricultural production and processing.

In their interviews, SFCs and installation contractors told the story of how their headquarters and branch offices came to be. The majority of the respondents stated that they had expanded their geographic coverage from 2007 to 2012: five of seven installation contractors and five of ten solar finance companies described their efforts to "follow the money" to new areas of California during this time period. Expansion tended to take one of three forms:

- Establishing new relationships with local subcontractors
- Servicing demand from existing facilities until business built up sufficiently to warrant establishing a new sales office or distribution warehouse
- Purchase of local solar PV installation contractor

Based on the interview responses, this evidence of sustainability appears to be present. Further evidence of sustainability would take the form of an expansion of top 20 installation contractor branches across California to meet customer demand.

Suggestions for Future Tracking

- Annual mapping of top 20 installation contractors based on interconnection data
- Bi-annual interviews with top 20 installation contractors

Data Sources

- PowerClerk data regarding top installation contractors
- Interviews of solar finance companies and installation contractors
- Internet search for addresses of headquarters and branch locations for top installation contractors

D.3.2.2 Indicator: Dollar Volume of Financing for Non-Incented Installation Increases

Description of MTI

This indicator seeks to measure the amount of capital that investors are willing to make available for PV installations that will not receive a CSI incentive. In general, solar PV finance companies may solicit two types of investment: equity financing to help support ongoing business operations, and project funds to invest directly in TPO systems. Such investments, however, do not typically prescribe whether the systems installed with that funding will or will not receive an incentive. Rather, they support a portfolio of projects that meet agreed-upon investment criteria (which may be achievable without an incentive). The fact that many of these companies and project funds span several states (each with different incentive levels and approaches) further complicates the goal of attributing funds to either incentivized or non-incentivized PV systems.

To evaluate this metric, the Navigate team focused on the individual and aggregate nominal dollar value of equity investments and project financings that solar PV finance companies have announced over the past four years. These announcements appear in general and industry-specific media, as well as on an individual company's websites or in their investment filings. Owners of larger non-residential systems may seek project-specific financing; however, the diversity of individual requirements and financing approaches makes tracking such transactions a more complex task.

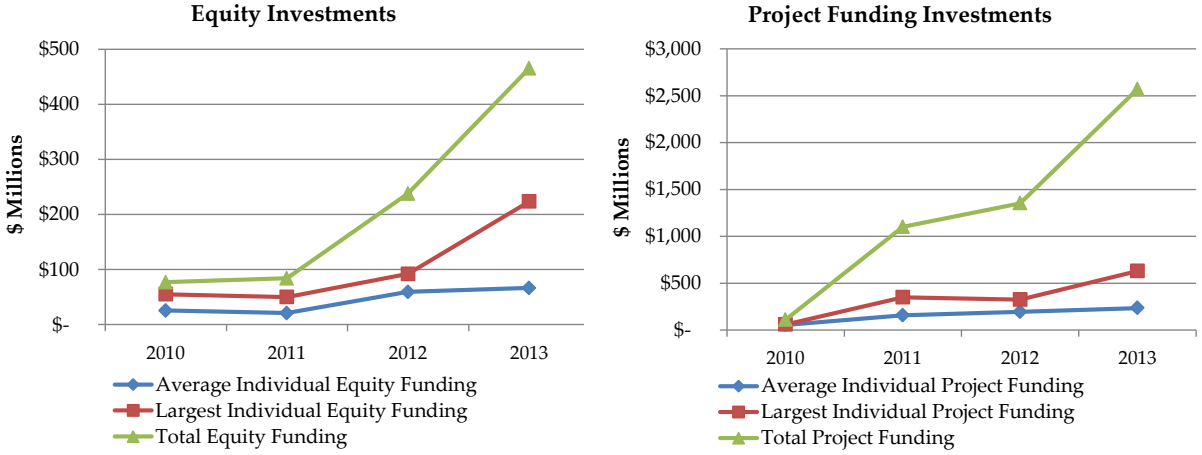
What this Indicator Tells Us About the Market

An increase in the dollar volume of equity investments and project funds (both individually and in aggregate) indicates that investors are becoming more comfortable with distributed solar PV as an investment opportunity. To the degree that these increases in financing amounts correspond to a continued lowering of incentives, one can infer that the supply chain for capital to invest in non-incentivized systems market is expanding. Conversely, if the amount of individual investments or the annual aggregate of those investments stagnates or contracts, it may indicate that capital providers are hesitant to continue investing in solar PV projects or companies as a result of market or policy signals (including the exhaustion of incentives).

Key Findings

1. The volume of equity and project-related investments announced by solar PV finance companies has climbed steadily over the past four years. Figure D-14**14** illustrates the average, maximum, and total dollar value of both equity and project-related investments announced each year from each of eight solar PV finance companies.[31]

Figure D-14. Investment Announcements for Eight Solar PV Financing Companies



Note: Data through November 20, 2013. Equity figures include SolarCity initial public offering (IPO) and subsequent issuances of stock and convertible debt, but exclude September 2012 Blackstone acquisition of Vivint, valued at $2 billion.

Source: Company press releases and news coverage.

[31] Companies included Clean Power Finance, One Roof, Solar Universe, SolarCity, Sungevity, SunPower, Sunrun, and Vivint.

As shown in the figures, the volumes of both individual investments and the aggregate of all investments have increased over the past four years for both equity and project-related financings. Investments in project funds in 2013 have totaled more than $2.5 billion to date, representing a more than $1 billion increase over the $1.35 billion invested in 2012. Similarly, the largest individual project-related financing in 2013 (SunRun's $630 million fund with JP Morgan Chase and U.S. Bank) was nearly double that announced in 2012 (SunPower's $325 million fund with Citi and Credit Suisse).

Thus far, these investment increases have continued despite continued declines and anticipated deadlines for most states incentive programs,32 as well as increasing uncertainty around net energy metering (NEM) policies. These investment levels indicate that the market has likely reached a level of sustainability and anticipated growth that will continue to attract capital despite current and future declines in rebate and incentive levels (barring any significant, unexpected shifts in market or policy conditions).

2. Leading solar PV finance companies are increasingly installing systems without incentives. As previously discussed, market actor interviews indicated that many solar PV companies are increasingly installing solar PV systems in California without CSI incentives. In parallel with the above finding on increasing investment levels, this reinforces the notion that investors are expanding the availability of capital for non-incentivized installations.

Suggestions for Future Tracking

Tracking financing announcements for solar PV finance companies is relatively straightforward and low cost. Company press releases and industry news coverage provide most of the requisite information. The deadlines and funding levels for existing state incentive programs are tracked and published via the Database of State Incentives for Renewables & Efficiency (DSIRE) website.

Data Sources

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